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A FAUNA OF THE VIGO GROUP: ITS BEARING ON THE EVOLUTION OF MARINE MOLLUSCAN FAUNAS

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TWO PLATES

A comparison of the rate of evolution of a marine invertebrate fauna in the Tropics with that of faunas of the temperate zones brings out some interesting results. During the past year, 1919–1920, the writer has had the opportunity and rare good fortune to collect some excellently preserved fossils from the Vigo group of the Philippine Islands, incidental to some economic investigations in which he was engaged. After several years spent in study of the faunal Tertiary problems of the Pacific Coast of North America, the writer naturally had acquired a point of view of the worker in temperate climes to a certain extent. However, many interesting problems in the Eocene of California, Oregon, and Washington suggested that marine Eocene molluscan faunas did not evolve as rapidly as those of the Miocene and Pliocene and that the same "yard stick" in the Tertiary geological time scale could not be applied. Many problems of the Eocene are directly connected with the rate of evolution of a tropical fauna and as the Eocene faunas of California, Oregon, and Washington are essentially tropical or subtropical, the writer was glad to devote spare time to the study of a tropical fauna.

Does the Lyell percentage system apply to tropical invertebrate faunas? In answering this question one must bear in mind that this scale is really an expression of the time rate of

evolution of Tertiary molluscan faunas based upon the study of the Tertiary of Europe. Briefly, this scale as now generally applied is:

Period.	Per cent.
Eocene	0
Oligocene	3
Miocene	25
Pliocene	60
Pleistocene	90

Practically all the Eocene molluscan genera exist to-day in the Recent faunas of the tropical and temperate zones. Great was our surprise to find that our collections from the upper Vigo shales and the Canguinsa formation, regarded by Pratt and Smith [1] as being of lower Miocene and Oligocene age, yielded a molluscan fauna containing 75 per cent Recent species. The results of these preliminary studies indicate that a negative answer must be given to the rhetorical question stated above. An essential modification of the Lyell percentage scale seems necessary to the writer for the proper interpretation of the Tertiary faunas of the Tropics. If this hypothesis is true then evidently marine molluscan faunal changes take place with far less rapidity in the Tropics than in the temperate zones. Now this conclusion is apparently in direct contradiction to the fact that the Recent molluscan fauna of the Philippines is specifically far more numerous than a Recent fauna from a temperate region. Hidalgo [2] reports from 4,300 to 4,500 land, terrestrial, fluvial, and marine testaceous mollusca, and of these fully two-thirds are marine. This anomaly will be considered after the presentation of the data.

Prof. K. Martin [3] recognized in a general way that the percentage system of Deshayes (and Lyell) did not strictly apply in Java, and that climatic variation was a prime cause of the differences.

BRIEF STATEMENT OF GEOLOGIC HISTORY

The fauna upon which this paper is based was collected from the southern half of the Bondoc Peninsula from strata referred by Pratt and Smith to the Canguinsa formation and Vigo

[1] Pratt, W. E., and Smith, W. D., The geology and petroleum resources of the southern part of Bondoc Peninsula, Philip. Journ. Sci. § A 8 (1913) 312.

[2] Hidalgo, J. G., Catálogo de los Moluscos Testáceos de las Islas Filipinas, Joló y Marianas. Madrid (1904–1905) 389.

[3] Martin, K., Die Tertiarschichten auf Java, Die Lagerunas verhaeltnisse. Leiden (1880) 22–24.

group. In order that the reader may appreciate the significance of this assemblage of mollusca, a brief resumé of the geologic history of that region is necessary. The southern half of the Bondoc Peninsula consists almost entirely of marine sedimentary rocks which have been highly folded and faulted. The oldest rocks here recognized consist of shales and sandstones from 3,000 to 4,000 feet in thickness, the Vigo group and its uppermost member, the Canguinsa formation. The strata as exposed in the vicinity of Vigo River are steeply dipping, black, organic shales, subordinate sandstones, and minor lignitic strata which are unconformably overlain by the Malumbang formation.[4]

The Malumbang formation consisting of coralline limestone and associated marls varies in thickness from small residuals to 1,000 feet. From what is known of the rate of growth of reef corals, this formation must represent a long time interval. In a few places in the Bondoc Peninsula—notably in the vicinity of San Andres—marine terraces truncate the Malumbang strata. These terraces are in places thickly mantled with coralline limestone of Pleistocene age. Some of the limestone four miles east of Mulanay, at an elevation of 500 feet, may represent high Pleistocene terraces, as terraces at this height occur in Leyte, and at much greater elevations in Cebu where the same geologic horizons are also found. These horizons exhibit the same essential conditions in northwestern Leyte and are beautifully exemplified in the vicinity of Toledo, Cebu, as well. The Vigo group in all probability occurs in the region north of Fort Pikit in Mindanao, so that we are not dealing with local conditions but with general ones which existed over the site of these islands. The conditions of deposition during Malumbang and Pleistocene time resembled those existing to-day in the vicinity of the Bondoc Peninsula, and essentially the same mollusca occur in the coral reef facies of all three. The deposition during Vigo time was in marked contrast with these later times, in that the contributing land masses consisted largely of diorites, schists, and serpentines or peridotites from which they were probably derived. At times the material contained in the Vigo sandstones is very coarse, and conglomerates occur locally in the Bondoc Peninsula and on a great scale in northwestern Leyte, east of the Barrio of Tababunga, where they in part closely resemble

[4] The writer's view concerning the stratigraphy of the region under discussion differs in this regard from that of Pratt and Smith, but a full exposition of this important point can not be given here.

characteristic desert fanglomerates. Such materials could not have been transported great distances and it is probable that a land mass or land masses lay to the east of the site of the Bondoc Peninsula and northwestern Leyte. In other words, the sediments of the Vigo group were deposited in the moderately deep waters of an inland sea with high mountainous islands to the east. The total time represented since the beginning of the Vigo is evidently long, and on these grounds as well as faunal the Vigo group appears to be as old as the Miocene, and the Malumbang probably represents at least a portion of the Pliocene. The time represented by the unconformity between these horizons was sufficiently long to reduce many of the mountains formed at the close of Vigo time to nearly base level before the region was again gradually lowered to receive its great load of Malumbang coralline limestone and associated marls in the clear, warm, shallow water of a tropical Pliocene sea. Likewise the orogenic movements which ended Malumbang time were fairly long continued, and the erosion interval which preceded the formation of Pleistocene terraces was not a brief one. The age of the Vigo group will be discussed at length after its fauna is considered.

FAUNA

The fauna upon which this paper is based was obtained from the Bahay River vicinity (2x, 3x, 4x, 5x) ; the cañon of Dumalog Creek (9x) ; and from Sapa Tubigbinukot, the northern extension of the Amoguis, Amougis, Agipot, or Pagsangahan River [5] (11x), from strata which are all unmistakably members of the Vigo group and unconformably below the Malumbang formation.

The following notes upon the collection localities and their fossils are given in detail, as there are but few places in these islands where good collections are obtained from localities with satisfactory stratigraphy.

The fauna noted in the following list was obtained from locality 2x, Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west shore of Ragay Gulf, 600 meters upstream from Bureau of Lands Bench Mark No. 1 (Bahay Oil Well No. 1), on the northeast bank of Bahay River in a 50-foot cliff of yellow sandstone and bluish clayey sandstone disturbed by minor faulting. Coll., Roy E. Dickerson.

The Malumbang limestone is found in the hill 100 yards to

[5] Different local names for the same stream.

the northeast and from the general relations in the field it is clearly unconformable upon the underlying Canguinsa formation.

Species from locality 2x.

Actaeon reticulatus K. Martin.
Architectonica pictum (Philippi); living.
Bullaria ampullaria (Linnæus).
Cancellaria crenifera Sowerby; living.
Cerithium jenkinsi K. Martin.
Cerithium moniliferum Kiener; living.
Cerithium herklotsi K. Martin.
Conus ornatissimus K. Martin.
Conus sp. nov.?
Conus lividus Hwass; living.
Conus sp.
Cyclonassa elegans Kiener.
Drillia.
Haminea.
Mangelia.
Mitra javana K. Martin.
Mitra cf. *jenkinsi* K. Martin.
Mitra junghuhni K. Martin.
Nassa crenulata (Bruguiere); living.
Nassa dispar Adams; living.
Nassa gemmulata (Lamarck); living.
Nassa globosa minor Quoy; living.
Nassa thersites immersa Carpenter; living.
Nassa quadrasi Hidalgo; living.
Nassa thersites leptospira Bruguiere; living.
Natica albumen Lamarck; living.
Natica?
Natica spadicea Reeve; living.
Natica mamilla Lamarck; living.
Nerita funiculata Reeve; living.
Nyctilochus.
Olivella.
Ranella subgranosa Beck; living.
Ranella.
Ranella tuberculata Broderip; living.
Strombus canarium (Linnæus); living.
Strombus swainsoni Reeve; living.
Terebra.
Terebra bicincta K. Martin.
Terebra javana K. Martin.
Turris (*Surcula*) *flavidula* Lamarck; living.
Turris garnonsi Reeve; living.
Turris deshayesi (Doumet); living.
Turris carinata woodwardi K. Martin; living.

PELECYPODA

Arca cornea Reeve; living.
Cardium sp.
Cardium donaciformis Cuming.
Chione chlorotica Philippi; living.
Corbula socialis K. Martin.
Corbula scaphoides Hinds.
Ostrea sp.
Pecten sp.
Pecten (*Pleuronectia*) *pleuronecta* Linnæus; living.
Pinna sp.
Placuna placenta Linnæus; living.
Psammobia cf. *lessoni* Blainville.
Solen sp.
Tellina.
Dentalium.
Coral.
Coral.
Echinoid.

The predominance of littoral species and the character of the strata indicate that these forms lived in the shallow inshore waters of an inland sea.

The following species were collected from locality 3x, Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west

shore of Ragay Gulf, Bahay River, upstream 800 meters from Bureau of Lands Bench Mark No. 1 (Bahay Oil Co. Well No. 1), on southwest bank of stream in a stiff dark gray shale. August 25, 1919. Colls., Roy E. Dickerson and Mark Fuken.

Species from locality 3x.

Actaeon reticulatus K. Martin.
Architectonica pictum (Philippi); living.
Cancellaria elegans Sowerby; living.
Cerithidea (*Pyrazus*) cf. *sulcatus* Bruguiere; living.
Cerithium herklotsi K. Martin.
Cerithium bandongensis K. Martin.
Cerithium jonkeri K. Martin.
Cerithium moniliferum Kiener; living.
Cerithium jenkinsi K. Martin.
Cerithium sp. nov.
Columbella bandongensis K. Martin.
Conus sp. nov.?
Conus sp.
Conus ornatissimus K. Martin.
Cypraea cf. *tigris* Linnæus; living.
Distortio clathrata Lamarck; living.
Melania asperata Linnæus; living.
Melania cf. *asperata inquinata* Quadras; living.
Mitra junghuhni K. Martin.
Mitra javana K. Martin.
Murex endivia Lamarck; living.
Nassa thersites leptospira (Bruguiere); living.
Nassa thersites immersa Carpenter; living.
Nassa quadrasi Hidalgo; living.
Nassa globosa minor Quoy; living.
Nassa crenulata (Bruguiere); living.
Nassa canaliculata Lamarck; living.
Nassa dispar Adams; living.
Natica mamilla Lamarck; living.
Natica lacernula d'Orbigny; living.
Olivella.
Phos roseatus Hinds.
Ranella tuberculata Broderip; living.
Rostellaria fusus Linnæus; living.
Rostellaria crispata Kiener; living.
Strombus canarium (Linnæus); living.
Strombus sp. a.
Strombus sp. b.
Telescopium telescopium Linnæus; living.
Terebra.
Triton pfeifferianum Reeve; living.
Trivia smithi K. Martin.
Turris garnonsi Reeve; living.
Turris (*Surcula*) *flavidula* (Lamarck); living.
Turris deshayesi Doumet; living.
Turris carinata woodwardi K. Martin; living.
Turris coronifer (K. Martin).
Voluta cf. *innexa* Reeve.

PELECYPODA

Arca ferruginea Reeve; living.
Arca granosa Linnæus; living.
Arca cornea Reeve; living.
Barbatia fusca (Bruguiere); living.
Chione chlorotica Philippi; living.
Corbula socialis K. Martin.
Corbula scaphoides Hinds.
Dosinia cf. *lenticularis;* living.
Paphia textrix Deshayes; living.
Placuna placenta Linnæus; living.
Psammobia sp.; living.
Ostrea.
Spisula sp.
Tellina sp.
Vermetus sp.
Coral.
Coral.

This fauna flourished in slightly deeper, or at least quieter, water as one specimen of the fragile *Placuna placenta* with both valves splendidly preserved shows that the specimen was not within strong wave action. The preservation of the other species is remarkably fine. The strata at this locality are nearly vertical, a good dip and strike being obtainable in the middle of the stream.

The following species were obtained from locality 4x, Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west side of Ragay Gulf, Bahay River; 320 meters east of the mouth of Apad Creek in road cut 60 feet above the river in yellow sandstone, about 50 feet stratigraphically above the brackish water fauna in the lignitic strata of locality 5. Colls., Roy E. Dickerson and Mark Fuken.

Species from locality 4x.

Architectonica pictum (Philippi); living.
Cerithidea cf. *ornata* Hinds; living.
Cerithium bandongensis K. Martin.
Columbella bandongensis K. Martin.
Conus ornatissimus K. Martin.
Cypraea sp.
Delphinula?
Delphinula reeviana Hinds.
Eburna ambulacrum Sowerby; living.
Marginella.
Melania asperata Linnæus.
Mitra bucciniformis K. Martin.
Mitra junghuhni K. Martin.
Mitra javana K. Martin.
Nassa costellifera A. Adams; living.
Nassa crenulata (Bruguiere); living.
Natica spadicea Reeve; living.
Phos roseatus Hinds; living.
Ranella tuberculata Broderip; living.
Ricinula spectrum Reeve; living.
Rostellaria fusus Linnæus; living.
Rostellaria crispata Kiener; living.
Strombus sp. a.
Terebra javana K. Martin.
Terebra bicincta K. Martin.
Trochus sp.
Turris marmorata (Lamarck); living.
Turris (*Surcula*) *flavidula* Lamarck; living.

PELECYPODA

Arca ferruginea Reeve; living.
Corbula socialis K. Martin.
Chione chlorotica Philippi; living.
Glycimeris viteus (Lamarck); living.
Pecten cf. *pseudolima* Sowerby; living.
Pecten cf. *cristularis* Adams and Reeve; living.
Pecten cf. *radula* Linnæus; living.
Pecten (*Pleuronectia*) *pleuronecta* Linnæus; living.
Placuna placenta Linnæus; living.
Solecurtus quoyi Deshayes; living.
Spondylus sp.

Locality 5x, Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, west side of Ragay Gulf, Bahay River; 300 meters east of the mouth of Apad Creek in lignitic gray sandstone which was deposited in brackish water. Coll., Roy E. Dickerson. This yielded the species listed below.

Species from locality 5x.

GASTROPODA

Cassidaria.
Cerithium jenkinsi K. Martin.
Cerithium sp. nov.
Conus loroisii Kiener; living.
Strombus (?) sp.
Telescopium telescopium Linnæus; living.

PELECYPODA

Arca tenebrica Reeve; living.
Chione (?) sp.
Ostrea sp.
Amber and petrified wood.

This fauna was made up largely of *Cerithium jenkinsi* K. Martin, *Cerithium* sp. nov., and *Ostrea* sp. The other forms are represented by only one or two species which were probably carried across the sand bar by small crabs that sidled over the sands of the Vigo Sea. The abundance of carbonaceous material and the occurrence of amber and petrified wood also indicate that conditions of deposition here differed from those in the previously described localities.

Locality 9x, Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, on Dumalog Creek; about 5 miles northwest of San Narciso, three-quarters of a mile downstream from the Mulanay-San Narciso Trail in uppermost Vigo just conformably below Canguinsa sandstone in black shale. October 17, 1919. Colls., Roy E. Dickerson and Mark Fuken.

Species from locality 9x.

Arca cf. *coelata* Reeve; living.
Arca ferruginea Reeve; living.
Buccinium simplex K. Martin.
Clementia hyalina Philippi=*C. papyracea;* living.
Conus striatellus Jenkins.
Conus hardi K. Martin.
Dosinia cretacea Philippi; living.
Mitra bucciniformis K. Martin.
Nassa crenulata (Bruguiere); living.
Strombus (?) *fusus* K. Martin (probably *Clavella*).
Tellina sp.

This fauna, though meager, is not distinct in any way from faunas listed above. As Pratt and Smith [6] point out, there is no evidence of any notable stratigraphic break here, and the stream in its meanderings so exposes the strata that exact observations are possible. Their tentative evidence of an unconformity between the Canguinsa and the Vigo in Cambagaco Ridge near Vigo River is interpreted by the writer as a result of faulting.

Locality 11x, Philippine Islands, Luzon, Tayabas Province, Bondoc Peninsula, on west bank of Sapa Tubigbinukot 400 yards upstream from Sapa Yaknas; in soft, yellow sandstone of Canguinsa age. October 31, 1919. Coll., Roy E. Dickerson. The strata at this point dip west about 20° while the overlying Malumbang, a few hundred feet west, has a gentle dip of 2° to 3°. At other places in this vicinity a notable unconformity separates these two formations. The fauna listed below is especially noteworthy as being composed of 85.90 per cent living species. Here again the stratigraphy is very satisfactory.

Species from locality 11x.

Architectonica pictum (Philippi); living.
Cancellaria elegans Sowerby; living.
Cerithidea near *dohrni*, but detail differs.
Cypraea sp.
Ficus reticulata (Lamarck); living.
Harpa articularis Lamarck; living.
Nassa thersites (Bruguiere); living.
Nassa crenulata (Bruguiere); living.
Nassa reussi K. Martin? (may = *N. costellifera* Adams).
Natica spadicea Reeve; living.
Natica cumingiana Recluz; living.
Ranella tuberculata Broderip; living.
Strombus swainsoni Reeve; living.
Terebra bicincta K. Martin.
Turris marmorata (Lamarck); living.

PELECYPODA

Cardita antiquata Linnæus; living.
Cardium attenuatum Sowerby; living.
Cardium unicolor Sowerby; living.
Clementia hyalina Philippi = C. *papyracea;* living.
Glycimeris viteus (Lamarck); living.
Glycimeris angulatus (Lamarck); living.
Ostrea.
Pecten pseudolima Sowerby; living.
Spisula sp.
Vermetus javanus ? K. Martin.

[6] Pratt, W. E., and Smith, W. D., Philip. Journ. Sci. § A 8 (1913) 317.

For comparison and summary purposes the fossils from these various localities have been combined in one list, as follows:

Partial list of species from the Vigo group.

	2x.	3x.	4x.	5x.	9x.	11x.	L.
Architectonica pictum (Philippi)	×	×	×			×	×
Actaeon reticulatus K. Martin	×	×					
Buccinium simplex K. Martin					×		
Bullaria ampulla (Linnæus)	×						×
Cancellaria crenifera Sowerby	×						×
Cancellaria elegans Sowerby		×				×	×
Cassidaria				×			
Cerithium jenkinsi K. Martin	×	×		×			
Cerithium herklotsi K. Martin	×	×					
Cerithium moniliferum Kiener	×	×					×
Cerithium bandongensis K. Martin			×				
Cerithium sp. nov		×		×			
Cerithium jonkeri K. Martin		×					
Cerithidea cf. *ornata* Hinds		×					×
Cerithidea (*Pyrazus*) cf. *sulcatus* Bruguiere			×				×
Cerithidea near *dohrni?*						×	
Conus ornatissimus K. Martin	×	×	×				
Conus sp. nov.?	×	×					
Conus sp	×	×					
Conus lividus Hwass	×						×
Conus loroisii Kiener				×			×
Conus hardi K. Martin					×		
Conus striatellus Jenkins					×		
Columbella bandongensis K. Martin		×	×				
Cyclonassa elegans Kiener	×						×
Cypraea cf. *tigris* Linnæus		×					×
Cypraea sp			×			×	
Drillia sp	×						
Delphinula?			×				
Delphinula reeviana Hinds			×				×
Distortio clathrata Lamarck		×					×
Eburna ambulacrum Sowerby			×				×
Ficus reticulata (Lamarck)						×	×
Haminea	×						
Harpa articularis Lamarck						×	×
Mitra javana K. Martin	×	×	×				
Mitra cf. *jenkinsi* K. Martin	×						
Mitra junghuhni K. Martin	×	×	×				
Mitra buccinifórmis K. Martin			×		×		
Mangelia	×						
Murex endivia Lamarck		×					×
Marginella			×				
Melania asperata Linnæus		×	×				×
Melania asperata inquinata Quadras		×					×
Nassa crenulata (Bruguiere)	×	×	×		×	×	×
Nassa dispar Adams	×	×					×
Nassa gemmulata (Lamarck)	×						×
Nassa globosa minor Quoy	×	×					×
Nassa thersites immersa Carpenter	×	×					×
Nassa thersites leptospira (Bruguiere)	×	×				×	×

Partial list of species from the Vigo group—Continued.

	2x.	3x.	4x.	5x.	9x.	11x.	L.
Nassa quadrasi Hidalgo	×	×					×
Nassa canaliculata Lamarck		×					×
Nassa costellifera A. Adams			×				×
Nassa reussi K. Martin (may = *N. costellifera*)						×	×
Natica albumen Lamarck	×	×					×
Natica?	×	×					
Natica spadicea Reeve	×		×			×	×
Natica mamilla Lamarck	×	×					×
Natica lacernula d'Orbigny		×					×
Natica cumingiana Recluz						×	×
Nerita funiculata Reeve	×						×
Olivella	×	×					
Phos roseatus Hinds		×	×				×
Ranella	×						
Ranella subgranosa Beck	×						×
Ranella tuberculata Broderip	×	×	×			×	×
Ricinula spectrum Reeve			×				×
Rostellaria fusus Linnæus		×	×				×
Rostellaria crispata Kiener		×	×				×
Strombus canarium (Linnæus)	×	×					×
Strombus, sp. a		×	×				
Strombus, sp. b		×					
Strombus swainsoni Reeve	×					×	×
Strombus (?) *fusus* K. Martin					×		
Strombus (?) sp				×			
Turris (*Surcula*) *flavidula* Lamarck	×	×	×				×
Turris garnonsi Reeve	×	×					×
Turris deshayesi (Doumet)	×	×					×
Turris carinata woodwardi K. Martin	×	×					×
Turris coronifer (K. Martin)		×					
Turris marmorata (Lamarck)						×	×
Terebra bicincta K. Martin	×		×			×	
Terebra javana K. Martin	×		×				
Terebra	×	×					
Triton pfeifferianum Reeve		×					×
Trochus			×				
Telescopium telescopium Linnæus		×		×			×
Trivia smithi K. Martin		×					
Voluta cf. *innexa* Reeve		×					
PELECYPODA.							
Arca cornea Reeve	×	×					×
Arca ferruginea Reeve		×	×		×		×
Arca granosa Linnæus		×					×
Arca cf. *coelata* Reeve					×		×
Arca tenebrica Reeve				×			×
Barbatia fusca (Bruguiere)		×					×
Cardium	×						
Cardium attenuatum Sowerby						×	×
Cardium donaciformis Cuming	×						×
Cardium unicolor Sowerby						×	×
Cardita antiquata Linnæus						×	×
Chione chlorotica Philippi	×	×	×				×
Chione?				×			

Partial list of species from the Vigo group—Continued.

	2x.	3x.	4x.	5x.	9x.	11x.	L.
PELECYPODA—continued.							
Corbula scaphoides Hinds	×	×					×
Corbula socialis K. Martin	×	×	×				
Clementia hyalina Philippi=*C. papyracea*					×	×	×
Dosinia cf. *lenticularis*		×					×
Dosinia cretacea Philippi					×		×
Glycimeris viteus (Lamarck)			×			×	×
Glycimeris angulatus (Lamarck)						×	×
Ostrea	×	×		×		×	
Faphia textrix Deshayes		×					×
Pecten (*Pleuronectia*) *pleuronecta* Linnæus	×		×				×
Pecten cf. *radula* Linnæus			×				×
Pecten cf. *pseudolima* Sowerby			×				×
Pecten pseudolima Sowerby						×	×
Pecten cf. *cristularis* Adams and Reeve			×				×
Placuna placenta Linnæus	×	×	×				×
Psammobia cf. *lessoni* Blainville	×						
Psammobia sp		×					
Pinna sp	×						
Solen sp	×						
Spisula sp		×				×	
Solecurtus quoyi Deshayes			×				×
Spondylus sp			×				
Tellina sp	×				×		
Tellina sp		×					
Vermetus javanus? K. Martin						×	
Vermetus sp. nov		×					

AGE OF THE VIGO GROUP

In the above list there are 98 forms that are specifically determined and of these 74, or 75.5 per cent, are living species, an astonishing number when the geologic history of the region yielding these forms is considered. In addition, the extinct forms are practically all common to the upper Miocene of Java, according to K. Martin.[7]

Cerithium jenkinsi is from Martin's locality Z; *Cerithium herklotsi* and *Cerithium bandongensis*, from his locality O; *Conus hardi* and *Conus striatellus*, locality O; *Columbella bandongensis*, locality O; *Mitra junghuhni* and *Mitra javana*, locality O; *Mitra jenkinsi*, locality K; *Mitra bucciniformis*, locality R; *Turris coronifer*, locality O; *Terebra javana* and *Terebra bicinta*, locality K; *Vicarya callosa*, localities O and P; and *Vermetus javanus*, localities I and P. According to Martin, most of these forms are characteristic of the upper Miocene of Java.

[7] Martin, K., Tertiarschichten auf Java. Leiden (1880) 44–51.

In a very excellent paper, entitled "Concerning Tertiary Fossils in the Philippines," Prof. Karl Martin listed a series of faunas from the Cagayan Valley of northern Luzon which apparently belong to this same horizon. Concerning these faunas he gives the following discussion:

Now, in reviewing Semper's collection, I was at once struck with *Vicarya callosa* Jenkins, which is known from Java and is described in detail below; and this induced me to make a closer comparison between the fossils of the Philippines and those of the Indian Archipelago, whereby it at once became apparent that a whole series of species, especially of the Javanese Tertiary is common to both regions. Thus far, indeed, I have been unable to make a complete study of Semper's collection, and for the time being it has little further interest, because statements as to stratigraphical position are entirely lacking and the equivalent deposits of neighboring regions are still very insufficiently known. After completion of my monograph on the fossils of Java, however, I hope to undertake a more thorough study of the Philippine fossils, and to supplement this preliminary communication.

Martin lists the following from Luzon:

1. Minanga; right bank of the Catalangan.

Fusus verbeeki Mart. M; P.
Tritonidea ventriosa Mart. M.
Murex brevispina Lam. M (?); P; L.
Murex pinnatus Wood. M; L.
Ranella raninoides Mart. M.
Rostellaria javana Mart. M.
Natica mamilla Lam. M; L.
Cardita decipiens Mart. P.
Venus squamosa Lam. P; L.

2. Minanga; right bank of the Ilaroen.

Terebra jenkinsi Mart. M.
Terebra bandongensis Mart. M.
Fusus verbeeki Mart. M; P.
Murex grooti Jenk. M.
Ranella gyrina Linn. L.
Rostellaria javana Mart. M.
Vicarya callosa Jenk. M.
Cardita decipiens Mart. P.

3. Right bank of the Ilaroen; 4 miles above Minanga.

Fusus verbeeki Mart. M; P.
Murex brevispina Lam. M (?) P; L.
Ranella raninoides Mart. M.
Rostellaria javana Mart. M.
Natica mamilla Lam. M; L.

4. Left bank of the Ilaroen; 1.5 miles above Goroen.

Murex djarianensis Mart. M.
Murex brevispina Lam. M (?); P; L.
Murex microphyllus Lam. M; L.
Murex grooti Jenk. M.
Ranella spinosa Lam. M; L.
Potamides jenkinsi Mart. P.
Natica mamilla Lam. M; L.
Cardita decipiens Mart. P.

5. Left bank of the Ilaroen; 4 miles above Goroen.

Conus sinensis Sow. P; L.
Conus palabuanensis Mart. J.
Fusus verbeeki Mart. M; P.
Ranella gyrina Linn. L.

6. Foothills in front of Aringay.

Conus loroisii Kien. M; P; L. *Nassa verbeeki* Mart. P.
Pleurotoma gendinganensis Mart. *Natica mamilla* Lam. M; L. P.

7. Hills close to Aringay.

Pleurotoma carinata. P; L.

8. Dicamui Brook.

Vicarya callosa Jenk. M.

9. Satput.

Cypraea smithi Mart. M. *Rostellaria javana* Mart. M.

The appended initials indicate the occurrence of the species in the Tertiary of other parts of the Indian Archipelago, as well as among the fauna of the present day. Thus E denotes Eocene; M, Miocene; P, Pliocene; J, later Tertiary in general; Q, Quaternary; L, living species.

The fossils in Martin's list come from nine different localities and the largest number of species from any one locality is ten. According to Martin, the strata in the vicinity of Minanga belong essentially to the same horizon, and he says:

> Judging from these facts, the strata of Minanga are to be classed with the upper Miocene bed which exists in Java in the locality denoted by Junghuhn by O and at Selatajan on the Tjilongan.

As was indicated above, many of the fossils from the Bondoc Peninsula are common to this locality O in Java, and the equivalence of the Upper Vigo beds with these Javan beds is evident. Upon the basis of Martin's work, the age of the Vigo beds is upper Miocene.

Martin lists the distinctive foraminifera, *Cycloclypeus communis* Martin from his (and Junghuhn's) localities K, L, O, and P.; *Orbitoides gigantea* Martin is from locality L; and *O. radiata* Martin is from locality K. These localities all represent about the same horizon in Java and it is important to note these forms here, as they are regarded as excellent horizon determiners.

Dr. W. D. Smith,[8] on the strength of the occurrence of *Cycloclypeus communis* K. Martin and *Lepidocyclina richthofeni* Smith, refers the Canguinsa sandstone to the middle or lower Miocene. His exact statement is as follows:

> * * * The limestone from Mount Morabi * * * contains *Cycloclypeus communis* K. Martin, which represents the middle Miocene, and large lepidocyclinas some of which are 45 millimeters in diameter and 5

[8] Pratt, W. E., and Smith, W. D., Philip. Journ. Sci. § A 8 (1913) 330.

millimeters broad in the thickened central portion. *Lepidocyclina richthofeni* Smith was identified among these. This species has been referred by Douvillé to the lower Miocene.

No definite age determinations can be made from the fossils in the Canguinsa sandstone proper. The fossils in the included limestone, however, are well known and have been used in correlation by various authorities. From their presence it is concluded that the Canguinsa sandstone should be placed in the middle Miocene, extending, perhaps into the lower Miocene.

In a recent publication, Prof. H. Yabe [9] gives a full discussion of correlation of these equivalent beds in Cebu, and Smith's and Douvillé's correlation tables are quoted. It is noteworthy that the beds under discussion are classified by Douvillé as Aquitanian. All who have studied the large foraminifera from the Philippine Islands agree that one of the characteristic genera is *Lepidocyclina*. Cushman [10] in a recent paper makes the following significant statement:

Because in general *Orbitoides* with some modification to be noted in a future paper, is Cretaceous, *Orthophragmina* Eocene and *Lepidocyclina* Oligocene, much importance is attached to these organisms in the investigation of problems of geologic correlation.

From another point of view the age of the beds in question might depend upon the age determination of the overlying Malumbang formation. Concerning the age of this formation, Pratt and Smith [11] state the case as follows:

The most conclusive evidence as to the age of the Malumbang series is found in the Lower limestone, which, on the basis of the fossil *Lithothamnion ramosissimum* Reuss * * * may be assigned to the Miocene. The upper beds in the series are apparently as young as the upper Miocene or the Pliocene. The formation is similar to the "étage marneux" which Verbeek assigns to the middle stage of the upper Tertiary for Java.

Concerning the range of this species, Prof. H. Yabe [12] notes the following:

This reef building organism is very often cited from the limestone of the Oligocene and Miocene ages of the Indo-Pacific region, its occurrence being known from Japan, the Philippines, Borneo, Timor, Amboina, New Guinea and adjacent islands, New Hebrides, Victoria, the Christmas Is. etc.

[9] Yabe, H., Notes on a Lepidocyclina limestone from Cebu, Science Reports (Geology), Tohoku Imperial Univ. No. 2, II 5 (1919) 40.

[10] Cushman, J. A., Orbitoid Foraminifera of the genus Orthophragmina from Georgia and Florida, Prof. Paper 108 United States Geologic Survey, (1918) 115.

[11] Pratt, W. E., and Smith, W. D., Philip. Journ. Sci. § A 8 (1913) 327.

[12] Yabe H., Notes on a Carpenteria-limestone from British North Borneo. Science Reports of the Tohoku Imperial Univ. (Geology) No. 1, II 5 (1918) 14.

In Japan it is found not only in Lepidocyclina and Miogysina-limestone and similar and equivalent beds of Formosa, Botel-tobakee, the Riukiu Islands and the Ogasawara-Jima, but also in the Lepidocyclina and Miogysina-limestones of the provinces of Sagami and Kae, 2, the Lithothamnion-limestones of Oyami-Yama and Megami-yami near Sagau, Province of Lotomi; and 3, the Lithothamnion-limestone intercalcated in an oil-bearing Tertiary complex of Echigo, 4, the Lithothamnion-limestone of Shiroiwa, Makatsuka-mura, Otsu-gou, Province of Natigo.

It is evident from these references that this form has considerable range in the Miocene and probably the Pliocene.

From all the evidence Canguinsa and Upper Vigo beds may be assigned to some stage of the Miocene, and the evidence of *Lepidocyclina* indicates a still greater age, the Oligocene.

IMPORTANCE OF GUIDE FOSSILS

Good guide fossils are far more difficult to select in connection with tropical Tertiary faunas of the Philippines than in connection with the California Tertiary, owing to the great predominance of Recent mollusca. As will be seen from a study of the fauna cited above, most of the forms which are extinct were originally described from a correlative horizon in Java. Of these, the writer is inclined to think that *Cerithium jenkinsi, C. herklotsi, C. bandongensis, Mitra javana, M. jenkinsi, M. junghuhni, M. bucciniformis, Turris coronifer, Terebra bicincta, Terebra javana, Vicarya callosa,* and *Vermetus javanus* will probably prove reliable guides among the mollusca. All of these species are representatives of highly organized genera and their extinction during the post-Miocene time was probably due to their inability to obtain life conditions suited to their highly specialized needs.

Corals, echinoderms, and the more highly organized foraminifera will probably prove to be even better horizon determiners, but their comparative infrequence in strata of the Philippines will at times preclude their use. The writer has not yet attempted to identify the corals and the echinoderms in the collections made, but their value will no doubt prove to be great. It seems that their evolution may have been greatly retarded, but much study will be required in this connection. For stratigraphic work in the Tropics, large and complete collections are necessary to obtain results of any value as, even with the best data available, geologic and paleontologic history is read with much difficulty. Much comparative material, both Recent and fossil, should be accumulated, as subspecific differences will be

recognized only through comparative studies. These subspecific differences are exceedingly important for minute separation and discrimination of strata deposited under tropical conditions.

FACTORS PROMOTING EVOLUTION OF PELECYPODS AND GASTROPODS

The changes in conditions of environment of marine pelecypods and gastropods—salinity, temperature, depth of water, character of bottom, food, oceanic currents—determine the existence of individuals, and in all probability species also. Many marine forms are very delicately adjusted to their environment, and even slight changes may cause their extinction in certain localities. Of these conditions, change in temperature is probably the most important. The annual temperature range of waters in the Tropics is far less than similar ranges in the temperate zones. Likewise, variations in salinity are probably less, as this is a secondary factor dependent in large part upon temperature. The influence of oceanic currents is intimately connected with temperature and salinity. Depth of water and the character of the bottom may be altered by changes in the volume of sediments brought into the ocean from the neighboring land and by epeirogenic (continent-building) movements which have caused a restriction or enlargement of a continental shelf. Epeirogenic movements vitally affect food conditions of pelecypods and gastropods; for, if the continental shelf is greatly reduced by uplift, the feeding areas are thus reduced, and if the competition among gastropods and pelecypods is too great, a species may rapidly become extinct. All of these changes are probably far less under tropical conditions than under temperate or arctic conditions.

COMPARISON OF LIFE CONDITIONS DURING VIGO-MIOCENE TIME WITH THOSE OF RECENT TIME

The close relationship between the Vigo-Miocene fauna of the Philippines and the Recent fauna of these same waters indicates that changes in living conditions since the beginning of Miocene time have been but slight. Apparently change in temperature has not had notable influence. It can be shown by general geologic evidence that an archipelagic condition existed during Miocene, Pliocene, and Pleistocene times. Salinity during the last half of the Tertiary and Recent has probably altered but little, and this only locally. Oceanic currents, and changes in character of ocean bottom were probably different during Vigo-Miocene time than during Malumbang-Pleistocene or Recent time, as is

evidenced by the absence of reef-building corals from the Vigo and by the argillaceous and sandy character of the sediments of this group. A study of Vigo sedimentation indicates that an extensive land area stretched from north to south near the outer border of the continental shelf of the Philippines, unbroken by straits like the San Bernardino of the present. Diorites, schists, serpentines, and associated metamorphic and igneous rocks composed this land mass and the mud-laden, westerly flowing streams deposited their loads in the Philippine inland sea of Miocene age. Judging from the coarse agglomeratic character of the basal Vigo beds in Leyte, high-grade torrential streams descended to a semi-arid lowland from a high mountainous terrane to the east. The absence of many reef-building corals from the Vigo fauna is probably due to the presence of muddy waters and the lack of strong currents because, judging from the presence of many tropical species, the waters were quite warm enough for coralline growth. From the character of both the sediments and the fauna, the waters of the Vigo sea were not too deep for the existence of reef-building corals. During Malumbang time marine life conditions were very similar to those prevailing in the Philippines to-day, but the continental shelf was apparently wider and the islands were much smaller, since coralline limestone covered more extensive areas during the Pliocene than now. During the Pleistocene the islands were outlined about as at present, but many local changes took place during this time. Cebu, for example, was probably greatly restricted during the Pleistocene as well as during the Pliocene, and it was probably represented by several small islets then. Recent and Pleistocene faulting on a great scale seems largely to have controlled the physiography of that island. The northwestern peninsula of Leyte, 40 miles east, has not only a clear-cut record in its terraced sides, registering a series of uplifts, but an equally clear record of Recent or Pleistocene submergence on its west side. This last event is evidenced by a series of beautiful small bays, drowned valleys of small westward-flowing antecedent streams. Such local movements did not seem to affect the species very materially on the whole. It is quite possible that some forms had to seek other quarters, but with such a great variety of neighborhood from which to choose, every clam could find its proper mud flat and each snail its own dugout.

The possible tendency of a species to have within itself the power to evolve into a higher form, or a form still better suited

to its environment, is not apparently present in the case of the tropical pelecypods and gastropods, and the slow changes of fauna are apparently produced by slight changes in temperature, depth, salinity, and food. In other words, the "wonderful stability of protoplasm" seems to be exhibited in these marine tropical invertebrates, except when environmental changes impress alterations upon this vital life substance.

CROWDING OF SPECIES AND THE RECENT FAUNA OF THE PHILIPPINES

A seeming objection to the main thesis of this paper is found in connection with the great abundance of species in the marine waters surrounding the Philippine Islands. As was mentioned above, climatic zones were by no means as sharply differentiated during the early portion of the Tertiary as during the later. Practically all Recent tropical genera were initiated in the Eocene, and many of the species representing these genera had during this period an exceedingly wide geographic range, particularly as respects latitude. During this time tropical species flourished in high latitudes. To use a simple comparison, the tropical life "accordion" was extended to its greatest limit. The exact nature of the change which caused a separation of remarkable distinctness between the Oligocene and the Eocene faunas of the Pacific Coast of North America is not fully understood. It seems probable, however, that the time represented by unconformity between Oligocene and Eocene was long. The distribution of land masses on the earth was profoundly affected, and it seems quite probable that the climate during this ep-Eocene time was decidedly cooler than in the Eocene or the Oligocene which followed. It seems quite probable that the life "accordion" was compressed, and that many species which ranged far to the north in Eocene time were compelled to seek the more genial climates of the tropic seas. When the faunas during the Oligocene again had a chance to expand into higher latitudes, they encountered new conditions of environment and were nearly all specifically changed. The Oligocene faunas of Oregon, Washington, and California are distinctly set off from the Miocene, and similar changes may have taken place during ep-Miocene time. Again, many of the species succeeded in making a strategic retreat. Even more pronounced were the "accordion"-like changes during the Pliocene and the Pleistocene.

As was pointed out above, archipelagic conditions prevailed in the Philippines during the Tertiary, although the record for the Eocene is missing, or extremely meager. An archipelago

located in the Tropics offers a great variety of habitat and a new species entering such a region could on this account find suitable conditions for existence.

From Miocene to Recent in the Tropics molluscan faunas have changed but little, and but slight specific alterations have occurred. Since a tropical or subtropical climate prevailed over California, Oregon, and Washington during upper Eocene time the great geographic and stratigraphic ranges of certain species of Tejon (upper Eocene) age are due to nearly uniform conditions of temperature and other factors mentioned. The great stratigraphic range of many Tejon-Eocene species is probably due to uniformity in climate during long periods of time, and slight faunal changes have greater significance in the upper Eocene than corresponding changes in the Miocene, Pliocene, and Pleistocene time; these variations probably required a much longer time for their production as well. Uniformity in oceanic temperature enabled many species to range far to the north, and in fact far west of California to the Eocene of Japan where *Perissolax blakei, Pholadomya nasuta,* or their near relatives occurred.[13]

Eocene time then must not be measured by the same faunal "yardstick" as Pliocene and Miocene time, but a much finer scale is required. It is the writer's opinion, based upon the above consideration, that Eocene time is far longer than any of the other divisions of the Tertiary.

SUMMARY

The tentative conclusion of the writer is that in the study of Tertiary faunas of the Tropics a different percentage scale must be used. For the later Tertiary, Miocene, Pliocene, and Pleistocene the percentages which apply in the temperate regions to the Pliocene are roughly adaptable to the Miocene; similarly, the percentages which apply in the temperate regions to the Pleistocene are apparently those of the Pliocene of the Tropics. This apparent lack of faunal differentiation during the Tertiary in the Tropics is due to uniformity of temperature, salinity, food, and other life essentials. From another viewpoint the rate of evolution of gastropods and pelecypods in the Tropics during the Tertiary was far less than during this same time in the more rigorous environs of the temperate zones. The tropical or subtropical faunas of the Pacific Coast of North America exhibit but slight differences compared to the faunas of Miocene and

[13] Yokoyama, M., Some Tertiary fossils from the Miiki coal fields, Journ. Coll. Sci. Imperial Univ. of Tokyo, 27 (1911).

Pliocene age of this same region, and the writer ascribes this to the uniformity of life conditions which prevailed during Eocene time. The amount of faunal change must not be used as a measure of time in the whole of the Tertiary, but in measuring the tropic and subtropic faunas differently marked scales are necessary for the Eocene and the Oligocene than for the Miocene, the Pliocene, and the Pleistocene. It is particularly noteworthy that the Japanese paleontologists are now searching for comparisons with the Pacific Coast of North America and Australia rather than with Europe. In other words, many problems of the tropical Orient will be solved only when conditions on both sides of the Pacific become better known.

ILLUSTRATIONS

PLATE 1

Relief map of the Philippine Islands.

PLATE 2

Relief map of Bondoc Peninsula, showing fossil localities cited.

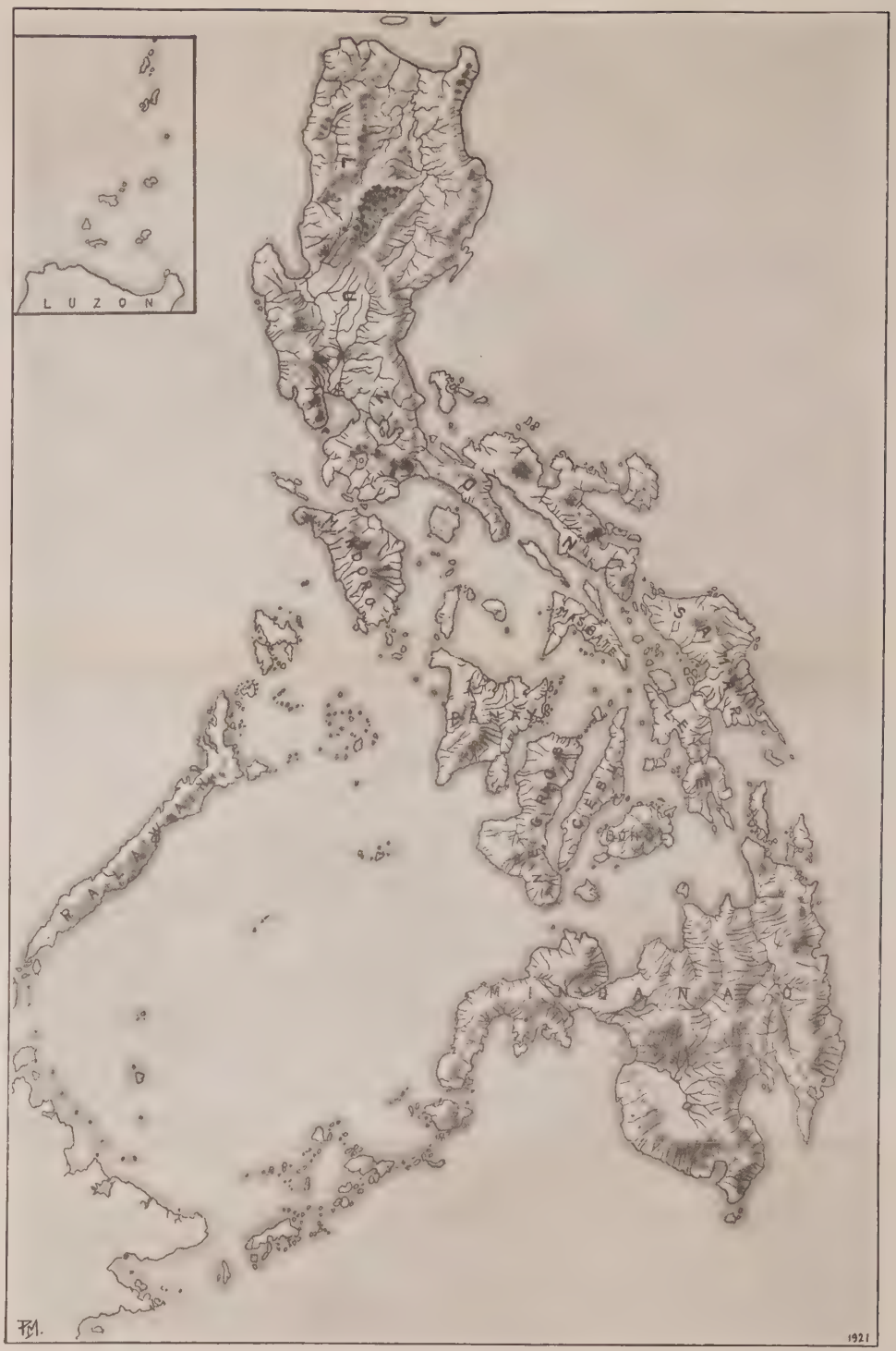

PLATE 1. THE PHILIPPINE ISLANDS.

PLATE 2. BONDOC PENINSULA, LUZON, P. I.

FURTHER NOTES ON PHILIPPINE SCYPHOMEDUSAN JELLYFISHES

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FOUR TEXT FIGURES

This paper has for its purpose the publication of miscellaneous new data concerning the scyphomedusan fauna of the Philippine Islands and includes the descriptions of two new genera and one new species. Since my former paper on Philippine Scyphomedusæ (1914), Mayer has published (1915) an article on the "Medusae of the Philippines and Torres Straits." The Philippine material for that paper, as well as that for his descriptions of Philippine forms in "Medusae of the World" (1910), came from the collections in Philippine waters of the United States Fish Commission Steamer *Albatross*. Mayer found thirty-one species and varieties from the Philippines in the *Albatross* collection. The forms reported in my paper (1914) from the collection of the University of the Philippines added seven to this number, and the new species described in the present paper makes a total of thirty-nine species and varieties of scyphomedusan jellyfishes known from Philippine waters.

This is a surprisingly large number when the smaller numbers found in other better-known regions and the incompleteness of the collections here are taken into consideration. Mayer (1915, p. 160) says:

> It is evident that the region of the Philippines is very rich in scyphomedusæ, for off the far better-known Atlantic coast of the United States there are but 25 species of scyphomedusæ and only 4 of these are Rhizostomæ, while among the 38 species taken by the *Albatross*, and by Light, in the region of the Philippines, 22 are Rhizostomæ. Among these 38 species 15 were new to science.

The new form described in this paper is a rhizostomid and brings the number of Philippine species belonging to that order to twenty-four and the number of species named from Philippine materials to sixteen. Of these sixteen species and varieties, all but one (*Discomedusa philippina* Mayer, 1915) are Rhizostomæ. It would seem, therefore, that the Philippines have

not only a rich but a very characteristic rhizostomid fauna. There is no doubt in my mind that more systematic collections with the proper facilities will increase very considerably not only the total of species but the number of new species from the Archipelago.

The list of species and varieties known from the Philippines, with notes on distribution, follows. Names and dates in parentheses refer to the recorders and the dates of publication.

Order CARYBDEIDÆ

1. **Carybdea rastonii** Haacke.
   Luzon and Mindoro (Mayer, 1910 and 1915).
2. **Carybdea alata var. grandis** Agassiz and Mayer.
   Manila Bay (Mayer, 1915).
   Carybdea alata var. *moseri* Mayer is probably an immature form of *C. alata* var. *grandis* as is *C. philippina* Semper, 1860 (Semper, 1860).
3. **Chiropsalmus quadrigatus** Haeckel.
   Common except in inclosed bays such as Manila Bay (Mayer, 1910 and 1915; Light, 1914).

Order CORONATÆ

4. **Periphylla hyacinthina** Steenstrup.
   Common pelagic form in deeper waters (Mayer 1910, 1915).
5. **Linuche unguiculata** (Schwartz) var. **aquila** Mayer.
   Mactan, Cebu (Mayer, 1910 and 1915).
6. **Atolla bairdii** Fewkes forma **wyvillei** Haeckel.
   Common pelagic form in deeper waters (Mayer, 1910 and 1915).
7. **Atolla bairdii** Fewkes forma **gigantea** Maas.
   (Mayer, 1915).
8. **Atolla bairdii** Fewkes forma **valdiviæ** Vanhöffen.
   Sogod Bay (Mayer, 1910 and 1915).

Order SEMÆOSTOMÆ

9. **Pelagia panopyra** Péron and Lesueur. (Mayer, 1915).
   Pelagia panopyra var. *placenta* (Haeckel) (Mayer, 1910).
   Common pelagic form in deeper waters (Mayer, 1910 and 1915).
10. **Chrysaora melanaster** Brandt.
    San Miguel Bay (Mayer, 1915).
11. **Dactylometra africana** Vanhöffen.
    Off Corregidor Light, Manila Bay (Mayer, 1915).
12. **Dactylometra quinquecirrha** L. Agassiz.
    Chrysaora stage very common in Manila Bay (Light, 1914).
13. **Sanderia malayensis** Götte.
    Common pelagic form in deeper waters (Mayer, 1910 and 1915).
14. **Discomedusa philippina** Mayer.
    Catingan Bay (Mayer, 1910 and 1915).
15. **Aurellia aurita** Lamarck.
    (Mayer, 1915).

16. Aurellia labiata Chamisso and Eysenhardt.
Masbate (Mayer, 1910); Jolo (Mayer, 1915); Manila Bay (Light, 1914).

Order RHIZOSTOMÆ

17. Cassiopea polypoides Keller var. culionensis Light.
Culion Island (Light, 1914).
18. Cassiopea medusa Light.
Culion Island (Light, 1914).
19. Cassiopea ornata Haeckel.
Simaluc Islands, Subic Bay, and Catbalogan, Samar (Mayer, 1910). This species is reported from the above localities by Mayer (1910, p. 648), but in his synopsis of described forms of *Cassiopea* (1910, p. 638) he does not give this distribution, and in his list of Philippine Scyphomedusæ (1915, p. 159) he gives only *C. andromeda* var. *baduensis* Mayer. He gives no record of this medusa from the Philippines, however, and its characters are not those of the Philippine forms placed under *C. ornata;* hence I believe the Philippine form to be *C. ornata* as above, and not *C. andromeda* var. *baduensis.*
20. Cephea cephea (Forskål) Mayer.
Mariveles (Light, 1914).
21. Cephea cephea var. cœrulea (Vanhöffen) Mayer.
Legaspi (Mayer, 1915).
22. Cephea octostyla (Forskål) Mayer.
Jolo (Mayer, 1910 and 1915).
23. Anomalorhiza shawi gen. et sp. nov.
Manila Bay (Light, this paper).
24. Cotylorhizoides (Cotylorhiza Mayer, 1915) pacificus (Mayer) gen. nov.
Manila Bay (Mayer, 1915; Light, this paper).
25. Catostylus purpurus Mayer.
Very common in Manila Bay (Mayer, 1910 and 1915; Light, 1914).
26. Catostylus mosaicus (Quoy and Gaimard) L. Agassiz.
Malampaya Sound, Palawan (Mayer, 1915).
27. Acromitus maculosus Light.
Taytay, Palawan (Light, 1914).
28. Lychnorhiza bartschi Mayer.
Jolo (Mayer, 1910 and 1915).
29. Mastigias papua (Lesson) L. Agassiz.
Luzon: Pagopas Bay (Mayer, 1910 and 1915); Manila Bay (Light, this paper)—Mindoro: Port Galera (Light, 1914)—Palawan: Taytay (Light, 1914)—Cebu: off Cebu (Mayer, 1915); Candamon Island between Cebu and Bohol (Mayer, 1915).
30. Mastigias ocellata (Modeer) Haeckel.
(Mayer, 1910 and 1915).
31. Phyllorhiza luzoni Mayer.
Luzon: Varadero Bay (Mayer, 1915).
32. Versura maasi Mayer.
Bohol: Montacao Island (Mayer, 1910 and 1915).
33. Lobonema smithii Mayer.
Manila Bay (Mayer, 1910).
34. Lobonema mayeri Light.
Taytay, Palawan and Manila Bay (Light, 1914 and this paper).

35. Lobonemoides gracilis Light.
    Taytay, Palawan (Light, 1914).
36. Thysanostoma thysanura Haeckel.
    Mindanao—Mindoro; Singaan Island—Luzon; Atuluyan Bay (Mayer, 1910 and 1915); Manila Bay (Light, this paper).
37. Lorifera lorifera var. pacifica (Schultze) Mayer.
    Port Palapog, Luzon (Mayer, 1915).
38. Lorifera flagellata (Haeckel) Mayer.
    Albatross Station D5226 (Mayer, 1910).
39. Rhopilema visayana Light.
    Taytay, Palawan (Light, 1914).

Since 1914 it has not been possible to make any extensive or systematic collection of Philippine Scyphomedusæ. Thanks, however, to the interest of Prof. W. R. Shaw, of the department of botany, University of the Philippines, and to occasional collections which I have been able to make in Manila Bay, a number of new facts as to distribution, structure, and classification have accumulated and with the finding by Professor Shaw of a specimen in good condition which represents a new genus and species (see *Anomalorhiza shawi* below) it seemed appropriate to bring our knowledge of Philippine Scyphomedusæ to date.

As in my paper of 1914, I follow closely the system of classification and generic diagnosis given by Mayer in his "Medusae of the World" and followed by him in his "Medusae of the Philippines and Torres Straits."

As all the material here referred to has been collected from Manila Bay, a list of the species of Scyphomedusæ known from that locality follows, with notes on numbers, collector, etc.:

1. Carybdea alata var. grandis Agassiz and Mayer.
   Two specimens collected by the *Albatross* at Station 5361, February 9, 1909, Manila Bay. Reported by Mayer (1915).
2. Dactylometra africana Vanhöffen.
   Five specimens collected by the *Albatross* at Station D5461, June 14, 1909, at a depth of 12 fathoms, about 7.2 miles off Corregidor Light, Manila. Reported by Mayer (1915).
3. Dactylometra quinquecirrha L. Agassiz.
   The *Chrysaora* stage is very common at Pasay beach, at Cavite, and probably at other points on Manila Bay. Reported by Light (1914).
4. Aurellia labiata Chamisso and Eysenhardt.
   Found rarely and in small numbers at Pasay beach. Reported by Light (1914).
5. Cephea cephea (Forskål) Mayer.
   Reported by Light (1914) from a single specimen from Mariveles.
6. Anomalorhiza shawi gen. et sp. nov.
   Reported here for the first time from a specimen collected by Professor Shaw, in whose honor it is named because of the interest he has always shown in the collection and classification of the jellyfishes of

Pasay beach. One mutilated specimen was collected by Gregorio Ylarde some years ago. A magnificent specimen was collected from the bay by Mr. Hilario A. Roxas, of the department of zoölogy, December 19, 1920, near Parañaque, with the assistance of Paulino Aguilar.

7. Cotylorhizoides (gen. nov.) pacificus (Mayer) 1915.
   Cotylorhiza pacifica MAYER, Pub. Carnegie Inst. Washington 212 (1915) 185–187.
   Reported by Mayer from a single mutilated specimen collected by the *Albatross* at the launch landing, Manila Bay. Common in Manila Bay at irregular intervals. Specimens collected by Shaw and myself at Pasay beach, May, 1918, and at other times.
8. Catostylus purpurus Mayer.
   The commonest jellyfish of Manila Bay and its tidal creeks (esteros). Reported by Mayer (1910 and 1915) and Light (1914).
9. Mastigias papua L. Agassiz.
   An occasional visitor to Manila Bay. Reported from the bay for the first time in this paper.
10. Lobonema mayeri Light.
    Very common during the summer months. Perhaps to be considered the same as the next species. Reported by Light (1914).
11. Lobonema smithii Mayer.
    Reported by Mayer (1910) from a single mutilated specimen. Perhaps the same as the preceding species.
12. Thysanostoma thysanura Haeckel.
    Reported here for the first time from Manila Bay from two perfect specimens collected by Doctor Shaw at Pasay beach, one in the summer of 1919 and the other in July, 1920.

In the following pages I shall consider these species in order placing them systematically and giving such notes concerning habits, morphology, classification, etc., as have accumulated since my paper of 1914. No attempt is made to give complete synonymies. References are to the original descriptions, change to present form of name, and to reports from Manila Bay.

Order CARYBDEIDÆ Gegenbauer, 1856

Genus CARYBDEA Péron and Lesueur, 1809

Carybdea alata var. grandis Agassiz and Mayer.

Charybdea grandis A. AGASSIZ and MAYER, Mem. Mus. Comp. Zool. Harvard College 26 (1902) 153, pl. 6, figs. 26–31.

Carybdea alata var. *grandis* MAYER, Medusae of the World 3 (1910) 511, fig. 329; Pub. Carnegie Inst. Washington 212 (1915) 171.

Mayer (1915) reports two specimens of this variety collected by the *Albatross*, at Station 5361, Manila Bay, February 9, 1909, in 12 fathoms. This is the only record of this form and I have never encountered it. It is the only record of any species of the family Carybdeidæ from Manila Bay and their presence was

probably due to chance currents as they are typically found along more exposed shores.

Order SEMÆOSTOMÆ L. Agassiz, 1862

Family PELAGIDÆ Gegenbauer, 1856

Genus DACTYLOMETRA L. Agassiz, 1862

Dactylometra africana Vanhöffen, 1902.

Dactylometra africana VANHÖFFEN, Wissen. Ergeb. deutsch. Tiefsee Expedition, Dampfer Valdivia, Bd. 3, Lfg. 1 (1902) 40, taf. 4, fig. 20; MAYER, Pub. Carnegie Inst. Washington 212 (1915) 180.

"Lappets and tentacles red. Red radial streaks over exumbrella. * * * Distinguished by its lappets being deeply pigmented near the margin on the exumbrella side." (*Mayer*, 1915.)

I have seen no specimen of this species, which Mayer reported (1915) from five specimens captured by the *Albatross* in Manila Bay in 12 fathoms, 7.2 miles off Corregidor Light, *Albatross* station D5461.

It is worthy of note that these specimens were in the *Chrysaora* stage; that is, with twenty-four sense organs and thirty-two tentacles, as are practically all of the specimens of *Dactylometra quinquecirrha* so common in Manila Bay. It is possible that these specimens and those studied by me and identified as *D. quinquecirrha* belong to the same species; either *D. africana*, although the distinguishing pigment is entirely lacking in the many specimens I have examined from Manila Bay, or *D. quinquecirrha*. Or it may be that the two forms are simply variants of the same variable species. Whatever their systematic position no other specimens of this type have been reported from Manila Bay, and it is probable that they are very rare visitors there.

Dactylometra quinquecirrha (Desor, 1848) L. Agassiz, 1862.

Pelagia quinquecirrha E. DESOR, Proc. Boston Soc. Nat. Hist. 3 (1848) p. 76.

Dactylometra quinquecirrha L. AGASSIZ, Cont. Nat. Hist. U. S. 4 (1862) 125, 166; MAYER, Medusae of the World 3 (1910) 585, pl. 62–64a, figs. 371, 372; LIGHT, Philip. Journ. Sci. § D 9 (1914) 198.

While the species belonging to the genus *Dactylometra* are characterized by the presence of 5 × 8 tentacles and 6 × 8 lappets, the medusæ pass through a *Chrysaora* stage in which they have the 3 × 8 tentacles and 4 × 8 marginal lappets characteristic of the genus *Chrysaora* Péron and Lesueur. Indeed it seems probable that some, if not all, of the forms referred to the genus

Chrysaora are immature or stunted forms of species of *Dactylometra.*

I have seen many specimens of this *Dactylometra,* the small white jellyfish which is extremely common in the bay at certain seasons of the year, particularly from June to November, but none of them have exhibited the 40 tentacles of the mature *Dactylometra.* One large specimen, collected by Doctor Shaw in June, 1920, shows the marginal lappets near the sense organ in each octant weakly divided, making the 6 × 8 marginal lappets characteristic of *Dactylometra* and confirming my diagnosis of this form as a species of *Dactylometra.*

This is the dangerous jellyfish of Manila Bay. Its sting is at all times most unpleasant and often extremely dangerous. Among the symptoms caused by its sting are excruciating pains across the back; general pains spreading from the region of the sting; in some cases a paralysis, also spreading from the region of the sting, in others intense cramps and, in severe cases, a watery discharge from the throat accompanied by a dry hacking cough and strong mental depression, which is so strong at times as to cause a desire to commit suicide. A friend visiting in Cavite tells me that this form is very numerous there at the present time (June, 1920), and is the cause of numerous very severe stings. In the case of a bather who dived head foremost into a medusa and was severely stung about the head the pain was so intense and mental symptoms were so serious, I am told, as to require the administration of morphine on several occasions. This all goes to prove my contention [1] that the cases of poisoning reported by Old (1908) were due to this *Dactylometra* rather than to *Lobonema* as Doctor Smith believed (Mayer, 1910), particularly since the symptoms reported in cases of poisoning by *Dactylometra* agree with those reported by Old.

Family ULMARIDÆ Haeckel, 1880, sensu Mayer, 1910

Subfamily AURELINÆ L. Agassiz, 1862

Genus AURELLIA Péron and Lesueur, 1809

Aurellia labiata Chamisso and Eysenhardt, 1820.

Aurellia labiata CHAMISSO and EYSENHARDT, Nova Acta Phys. Med. Leop. Car. 10 (1820) 358, pl. 28 figs. 1 A. B.; MAYER, Medusae of the World 3 (1910) 628, fig. 398; LIGHT, Philip. Journ. Sci. § D 9 (1914) 200; MAYER, Pub. Carnegie Inst. Washington 212 (1915) 182.

[1] Philip. Journ. Sci. § B 9 (1914) 295.

No specimen of this species has been recorded from Manila Bay since my former paper (1914).

Order RHIZOSTOMÆ Cuvier, 1799

Rhizostomata dichotoma Vanhoffen, 1888

Genus CEPHEA Péron and Lesueur, 1809

Cephea cephea (Forskål, 1775) sensu Mayer, 1910.

Medusa cephea FORSKÅL, Descrip. Anim. Itin. Orient. (1775) 108, No. 22, Icon., tab. 30 (non tabl. 29).

Cephea cephea MAYER, Medusae of the World 3 (1910) 654, 655; LIGHT, Philip. Journ. Sci. § D 9 (1914) 206; MAYER, Pub. Carnegie Inst. Washington 212 (1915) 185.

This species has not been recorded from Manila Bay since 1914. It is probably only a chance visitor to Manila Bay.

Genus ANOMALORHIZA novum

Generic diagnosis.—Rhizostomata dichotoma, the bifurcation of whose mouth arms is confined to a small distal region. A terminal, club-shaped appendage containing a continuation of the mouth-arm canal is found arising from the inner surface of each mouth arm at the point of bifurcation. Small, very slender, threadlike filaments are scattered among the mouth arms. The 8 sense organs have small exumbrellar sensory pits, and distinct

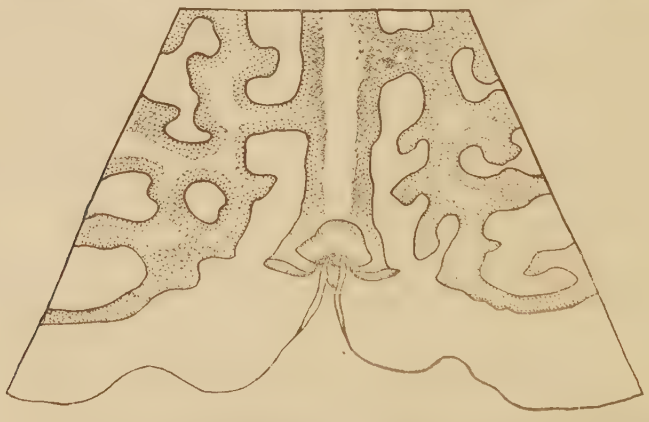

FIG. 1. A sense organ of *Anomalorhiza shawi* gen. et sp. nov. as seen from the subumbrellar side showing the subumbrellar shelf. × 6.

subumbrellar shelves (see fig. 1). A distinct ring canal anastomosing externally with a canal system extending to the margin and internally with 16 radial canals, the 8 rhopalar canals extending to the sense organ, the 8 interocular canals not being

distinguishable beyond the ring canal, the centripetal system consisting of one blind canal between each two radial canals (see fig. 2). Subgenital ostia wide and narrow, much wider than the base of the mouth-arm pillar. Subgenital porticus unitary.

FIG. 2. A quadrant of *Anomalorhiza shawi* gen. et. sp. nov. in subumbrellar view, showing canal system, subgenital ostium, etc. × 1.

Type species, *Anomalorhiza shawi* sp. nov.

This new genus differs strikingly from the other genera of *Rhizostomata dichotoma* in the unusual branching of the mouth arms, which are dichotomously branched only near the tip, the entire outer surface of the arm being quite bare; in the presence of a very large, distinct ring canal; in that the interocular canals are but 8 in number; and in the absence of any externally visible musculature. It is most nearly related to *Cotylorhizoides* (see diagnosis below) in that they both have terminal clubs on the mouth arms, large subgenital ostia, and small exumbrellar sensory pits, but differs from *Cotylorhizoides* in the points mentioned above and also more strikingly in the thinness and fragility of the bell as contrasted to the stiff massive bell of that form.

Anomalorhiza shawi sp. nov. Figs. 1 to 3.

The bell, which in the entirely relaxed, preserved specimen is nearly flat and measures about 150 millimeters in diameter, is

thickest between the ring canal and the base of the mouth-arm pillars (about 20 millimeters in thickness) while the area beyond the ring canal is very thin and tapers gradually to the extremely thin lappets. In a magnificent specimen, obtained since the illustrations were completed and after this paper was in proof, the bell in life was observed to approach a hemisphere and to have a minimum diameter of about 400 millimeters. The whole organism was very soft and pliable and when extended in death measured 600 millimeters or more in diameter.

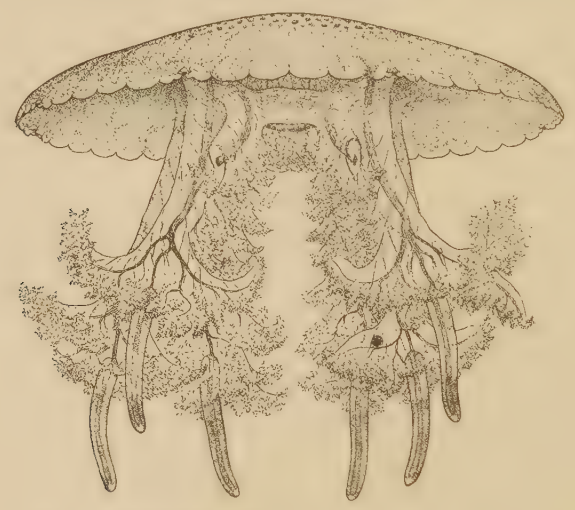

FIG. 3. *Anomalorhiza shawi* gen. et sp. nov. × 0.5. Two mouth arms have been cut away in front. (The specimen was very much relaxed and in life the bell is much deeper.)

The entire exumbrella with the exception of the grooves between the marginal lappets is thickly set with low, flat, wartlike projections colored a velvety brown. These warts increase in size from the margin, where they average a few millimeters in diameter and are most irregular in shape and deep in color, to the region of the exumbrella internal to the ring canal, where they reach a diameter of 20 millimeters or, where elongated, a length of 30 millimeters, and are more lightly colored and more elevated. This color fades out in preserved specimens but the warts remain conspicuous. These thickset brown spots give the only color to the bell, which is transparent white, the canals being slightly opaque white and the gonads, which protrude widely from the subgenital ostia of the adult, are opaque white in young specimens and a beautiful pale violet shading into pale pink in the adult.

The 8 rhopalia are small but distinct and have a porcelain-white color in life. There is a very small exumbrellar sensory pit and a distinct subumbrellar shelf. (See fig. 1.)

The marginal lappets are very thin and fragile and quite transparent, the canal system not extending into them. There are 6 velar lappets in each octant, the 2 lying next the ocular lappets being smaller than the other 4. The lappets present only a slight convexity and in large specimens are hardly to be made out distally. They are separated on the exumbrellar surface, however, by distinct, broad and deep grooves which are marked by the absence of the warts and the brown color of the remainder of the exumbrella. In the largest specimen there appear, in the center of many of these grooves, small rudimentary lappets marked by a slight distal projection and a very small area of brown color.

The mouth-arm disk which is 4-sided has a width of 45 millimeters in the figured specimen. Each mouth-arm pillar (two united mouth arms) has a diameter of 20 millimeters where it joins the mouth-arm disk, and a minimum diameter of 10 millimeters between the subgenital ostia which have a width of about 30 millimeters, or 3 times that of the pillars which separate them. The subgenital porticus is unitary.

The mouth arms, which in the figured specimen are about 70 millimeters long, exclusive of the terminal clubs, are very narrow externally and flat in the radial plane, the fleshy, unbranched portion being 20 millimeters broad and only 7 millimeters thick. The outer surface is bare for about 50 millimeters after which the arm is dichotomously branched once and each branch twice dichotomously divided again. The inner surface of each branch and of each arm is also alternately branched. The mouths surrounded by tiny tentacles are scattered rather sparsely on the inner and lower surfaces of the minor branches. Scattered between the mouths and most numerous near the center of the disk are very small, slender, delicate filaments, and projecting from the tip of each arm, giving it an appearance quite different from more typical *Rhizostomata dichotoma,* is a terminal club having a length of about 35 millimeters. This club, which has a surface color of light diffuse brown, is covered with low nematocyst-bearing warts and contains a continuation of the main canal of the arm at least half the diameter of the club and showing, like all the canals of the mouth arms, the clear purple color which gives this medusa a most beautiful and distinctive appearance.

In the large specimen referred to above, the mouth-arm disk is approximately 150 millimeters in diameter, the subgenital ostia have a maximum aperture of about 180 millimeters, and the mouth-arm pillars show a minimum diameter (at the center of the subgenital ostia) of about 65 millimeters. The mouth arms are about 340 millimeters long, the undivided portion being about 280 millimeters long. The fleshy, unbranched portion is about 60 millimeters broad and 17 millimeters thick. The mouth-arm club is distinctly pedunculated, more than 150 millimeters in length (all are imperfect) and about 12 millimeters in diameter. The proximal half of its central canal is a mottled brownish purple, the distal half of the purple color characteristic of the mouth-arm canals of the species.

The canal system consists of 16 broad, radial canals: 8 ocular canals which run to the margin and bifurcate at the base of the sense organ (see fig. 1), and 8 interocular. The interocular canals end at the ring canal, which is very broad and distinct and is connected externally to the canal network of the margin by several small branches in each octant (7 in the specimen figured), and gives off internally between each 2 radial canals (that is, 2 in each octant) a single, broad and very short, blind diverticulum. The interocular canals are considerably larger than the ocular canals which are narrowed proximally.

The muscles are poorly developed, not being visible externally.

I have named this strikingly beautiful medusa after Prof. W. R. Shaw, of the department of botany, University of the Philippines, who collected the first perfect specimen (figured here) and whose untiring interest in collecting specimens from Pasay beach is responsible for much of the data in this paper. While this paper was with the printer, Mr. Hilario A. Roxas, assistant in the department of zoölogy, collected the splendid specimen referred to above.

Genus **COTYLORHIZOIDES** novum

Generic diagnosis.—Rhizostomata dichotoma with 8 simple bifurcated mouth arms, the terminal branches of which branch pinnately. Subgenital porticus unitary, 8 marginal sense organs with or without ocelli and exumbrellar sensory pits, 8 large rhopalar canals and many small, anastomosing, interocular canals. No radial muscles. Strong circular muscles interrupted in the 8 principal radii. Circular canal small or absent. Bell high and dome-shaped, without a central dome-shaped region as in *Cotylorhiza.*

Type species, *Cotylorhiza pacifica* Mayer.

Cotylorhizoides pacificus (Mayer) emend.

Cotylorhiza pacifica MAYER, Pub. Carnegie Inst. Washington 212 (1915) 185.

Bell deeply dome-shaped, reaching a diameter of 300 millimeters and a depth nearly as great. Exumbrella covered with a mosaic of faint diffuse brown due to large numbers of minute brown spots, apparently clumps of Zoöchlorellæ (unicellular symbiotic algæ). In formalin specimens this color fades out entirely, and in alcohol specimens it remains as a mosaic of frosty white. A band extending from the inner ends of the velar clefts to about the middle of the velar lappets is a dull blue in some living specimens, due to the blue color of the canal network of that area. The exumbrella is more or less regularly marked by porcelain-white spots which have a characteristic appearance, due to their being pear-shaped with the swollen portion submerged; only the smaller end appears on the surface, where it simulates the opening of a gland, being transparent in the center. This transparent spot which simulates the opening is surrounded by a porcelain-white area, this by a transparent area, this by an area of diffuse brown, and this finally by an opaque white zone. These spots are about 5 to 10 millimeters apart on the surface, have a surface diameter of about 1 millimeter, and are from 2 to 4 millimeters in diameter at their widest point, which is usually internal. Toward the periphery these spots become more irregular, often larger, and sometimes more numerous. The exumbrella is also covered with minute cone-shaped papillæ.

Each of the 8 sense organs shows a single, large, brown ocellus which fades out in formalin. Above each sense organ is a small, but deep, exumbrellar sensory pit.

The rhopalar canals are large and distinct; the numerous interocular canals which anastomose freely with each other and with the ocular canals are much smaller than the ocular canals. The ring canal, while small, can be demonstrated by injection or dissection.

There are no radial muscles. The strong circular muscles extend to the bases of the mouth-arm pillars and are interrupted in the rhopalar areas, completely so internal to the ring canal and nearly so external to it.

The subgenital ostia are about one and a half times as wide as the mouth-arm pillars and have a convex lower border. In a specimen, 200 millimeters in diameter, the mouth-arm disk had a diameter of 110 millimeters; the perradial mouth-arm pillars were 40 millimeters across, and the subgenital ostia, 60.

The floor of the stomach is reënforced by four perradial thickenings corresponding to the walls separating the subgenital portici in forms such as *Cotylorhiza*.

Besides the numerous, small, pedunculated, knobbed appendages, the mouth arms bear large, rather stiff clubs which break off on lifting the medusæ from the water. The club at the distal end of each mouth arm is very long and of a solid consistency. Proximally it is transparent and spindle-shaped, narrowing distally before it expands to form a three-sided, dart-shaped region, which is frosted white proximally and grayish green distally and contains very powerful nematocysts, able to pierce the skin of the palm of the hand. They evidently contain no poison, however, as they cause no itching or burning sensation. These clubs contain anastomosing canals like those of Mastigias.

The mouth arms are short, fleshy, and thick and show window-like openings in the lateral membranes like those of Mayer's *Cotylorhiza pacifica* (placed here in *Cotylorhizoides*) and *Lobonema*. The mouth arms of a specimen measuring 200 millimeters in diameter (in preservation) were 80 millimeters in length, the upper arm being 20 millimeters long.

This very large and striking medusa is common in Manila Bay at apparently irregular intervals. The specimens upon which this description is based were collected by Doctor Shaw in May of 1918. I found them common among the more numerous *Lobonemæ* at that time. They appear to be very sluggish, their sting is negligible, and, having no long, flexible, nematocyst-armed appendages (like the tentacles of *Chiropsalmus*, the tentacles and oral lobes of *Dactylometra*, and the filaments of *Lobenema*) and being very conspicuous, they are seldom, if ever, a source of annoyance to fishermen or bathers.

Mayer's description of *Cotylorhiza pacifica* was made from a single mutilated specimen. While the forms here placed in that species differ from the description of *C. pacifica* in certain points, most strikingly in the presence of exumbrellar sensory pits and ring canal, I am inclined to attribute these differences to the poor condition of Mayer's specimen. A reëxamination of the type in the light of our present knowledge would probably show it to be in agreement with the above description. If not, the form described here must be considered as a new species, for which I propose the name *Cotylorhizoides punctatus* because of the striking porcelain-white spots which characterize this form.

I was at first inclined to consider this a new species until a reëxamination of the type of *C. pacifica* showed otherwise; but

this leads to a very unpleasant situation exemplified by the two species of *Lobonema,* which will be discussed later.

The present description from living material has added many points not discernible in fixed material, such as the presence of an ocellus in the sense organ which fades out in formalin material, the remarkable coloration of the exumbrella, and the presence of the long, characteristic mouth-arm clubs which break off when the medusa is taken from the water.

Mayer (1915, p. 187), speaking of *Cotylorhiza pacifica,* says:

> It differs from *Cotylorhiza tuberculata* in having no radial-muscles, and in the circular muscles being interrupted in the 8 principal radii. The subgenital ostia and arm-disk are larger and the appendages of the mouth-arms smaller and fewer than in *C. tuberculata.* Moreover, the peculiar window-like openings in its mouth-arm membranes at once distinguish this species.
>
> These distinctions are indeed of such a nature that if one felt so inclined a new genus could be established to receive this medusa. I believe, however, that its relationships will be more clearly indicated by placing it in the genus *Cotylorhiza,* within which it forms a well-marked species.

In view of the additional differences here brought out such as the presence of an exumbrellar sensory pit, an ocellus, a ring canal and the large, distinctive, mouth-arm clubs, it becomes necessary to erect a new genus to receive this very characteristic species which, while it resembles *Cotylorhiza* in certain points, differs from it very widely in many important characters. This resemblance I have indicated in the name *Cotylorhizoides.*

IMMATURE FORM OF COTYLORHIZOIDES PACIFICUS (FIG. 4)

A small medusa measuring in the specimens seen from 20 to 30 millimeters in diameter is present in small numbers in Manila Bay at irregular intervals. In its superficial appearance it resembles *Mastigias papua,* having the same brownish color of the bell and a terminal club on each mouth arm predominantly purple in color.

More careful examination shows it to agree in generic characters with *Cotylorhizoides,* and to differ from *Cotylorhiza pacifica* only in characters which might well be due to immaturity. The points in which it differs are the lack of the white spots which characterize the adult *Cotylorhiza pacifica* and the absence of the pedunculated clubs on the mouth arms.

The number and arrangement of the marginal lappets are those characteristic of *Cotylorhiza pacifica;* that is, in each octant, a pointed ocular lappet, two single velar lappets, two double velar lappets, two single velar lappets, and a single ocular

lappet, making ten in all if the individuals of the double lappets are counted.

The sense organ appears large and shows a distinct brown ocellus which does not fade in formalin as does that of the adult. The small but deep exumbrellar pit agrees with that of the adult *Cotylorhiza pacifica.*

The terminal mouth-arm clubs of the immature form are nearly as long as the mouth arms; these clubs are purple, except at the somewhat swollen, three-sided distal region, where they are frosty white.

That these are immature forms is shown by the absence of well-developed gonads, the small size, the large size of the sense organs and ocular lappets in proportion to the size of the velar lappets, and the fact that at the inner base of each mouth-arm pillar there is often found a portion of the original central mouth as yet unclosed.

SYSTEMATIC POSITION OF ANOMALORHIZA AND COTYLORHIZOIDES

The two new genera of *Rhizostomata dichotoma* here described but emphasize, as Mayer has already pointed out, that we are not dealing with a sharply defined group. He states (1910, p. 663):

> There is no sharp line of demarkation between the *Rhizostomata dichotoma* with mouth-arms V-like in cross-section and the *Rhizostomata triptera* wherein the arms are Y-shaped in cross-section.

He points out that further means of differentiation are the strong radial and weak circular muscles and the absence of the ring canal in *Rhizostomata dichotoma.* In *Cotylorhizoides,* however, there are very strong circular muscles, no visible radial muscles, and a ring canal. The only characters left to place it among the *Rhizostomata dichotoma* are the division of the mouth arms and the arrangement of the mouths upon the mouth arms. A glance at fig. 4, which is a very true representation of the appearance of an immature specimen of this species, will show how strikingly it simulates the appearance of the *Rhizostomata triptera,* particularly *Mastigias* with which it is very apt to be confused.

FIG. 4. Immature individual of *Cotylorhizoides pacificus* (Mayer). × 1.

Indeed, a study of this species seems to show a much greater affinity to *Mastigias* with its club-shaped appendages terminating the mouth arms, its numerous anastomosing interradial canals, its large subgenital ostia, its ring

canal, and its circular muscles than to *Cotylorhiza* and the other genera of the *Rhizostomata dichotoma.*

Much more so is this true in the case of *Anomalorhiza.* Here even the branching of the mouth arms is difficult to homologize with the other *Rhizostomata dichotoma,* since they branch dichotomously only near the tip, and the axial canal is continued downward into the terminal club. Here also there are no other characters to place it with this group. On the other hand, however, it is equally hard to place it among the *Rhizostomata triptera* on the basis of its mouth arms. Indeed, it is because of this anomalous condition of the arms that I have given it the generic name *Anomalorhiza.*

Rhizostomata triptera Vanhöffen, sensu Maas, 1903

Genus CATOSTYLUS L. Agassiz, 1862

Catostylus purpurus Mayer.

Catostylus purpurus MAYER, Medusae of the World 3 (1910) 671, fig. 412; LIGHT, Philip. Journ. Sci. § D 9 (1914) 207; MAYER, Pub. Carnegie Inst. Washington 212 (1915) 187.

This is the commonest jellyfish of Manila Bay. Its bell, varying in color from deep brown to black through purple, is to be seen at practically all seasons of the year dotting the shallower waters of the bay and its tidal streams and creeks (esteros).

In a former note [2] I spoke of this medusa as not being capable of administering a sting of any severity. Statements on the part of bathers that the sting was severe when the mouth arms of the medusæ came into firm contact with the body led me to experiment on myself. I rubbed the mouth arms of a large specimen across the back of my wrist. There was no immediate severe stinging sensation as is the case with *Lobonema,* but it was more intense and of longer duration. I quote from my notes: "The area soon became very red and hot with a pronounced stinging and burning sensation. This was relieved somewhat by application of ammonia but much more so by powdered sodium bicarbonate. The relief was only temporary and numerous applications were necessary. Although the burning sensation passed away after a few hours the area was still sore some twelve hours later. About three hours after the sting the bones and joints began to ache as in dengue fever, and this was accompanied by a dull but persistent ache over the kidneys and a dull headache. After taking 10 grains of aspirin the symptoms were much alleviated."

[2] Philip. Journ. Sci. § B 3 (1908) 329.

One interesting thing noted about this medusa was its ability to free its nematocysts or its poison on being handled or moved about by the waves. This is particularly noticeable when specimens are lifted from the water and returned. Persons standing in the water within a radius of five feet experience a most unpleasant, but merely temporary, burning and itching sensation on those parts of the body at the surface even though covered with a bathing suit. I am told that when these forms are numerous bathing becomes unpleasant along the exposed water front, due to the release of this poison or the nematocysts by the medusæ which are beaten about in the surf.

IMMATURE FORMS

This species evidently completes its life cycle in the bay since very small forms are abundant at times. Several collected by Doctor Shaw in June, 1920, show interesting stages in development. The smallest of these is 7 millimeters in diameter. The central mouth is just closing, being closed at the center with the four corners still open. Three of the four corners of the mouth have begun to bifurcate forecasting the 8-armed condition of the adult. Along each side of the gutterlike furrows which represent the open portion of the mouth is a single row of tentacles.

The centripetal vessels are represented by but a single short, blind canal between each two radial canals and unconnected with either radial canal. In this stage *Catostylus* which in the adult condition has its centripetal vessels communicating with all 16 radial canals, and *Acromitus* which in the adult form has its centripetal vessels joining only with the 8 rhopalar, would probably be indistinguishable. However, in a specimen 13 millimeters in diameter, the centripetal vessels join the 8 adradial canals, while in *Acromitus* they join the 8 rhopalar canals and not the adradials. In specimens of 20 millimeters or more in diameter the centripetals anastomose with all the radial canals, as in the adult.

Genus MASTIGIAS L. Agassiz, 1862

Mastigias papua (Lesson) L. Agassiz.

Cephea papua LESSON, Voyage de la Coquille, Zooph. (1829) 122, pl. 11, figs. 2, 3.

Mastigias papua L. AGASSIZ, Cont. Nat. Hist. U. S. 4 (1862) 152; MAYER, Medusae of the World 3 (1910) 678, fig. 415; LIGHT, Philip. Journ. Sci. § D 9 (1914) 209; MAYER, Pub. Carnegie Inst. Washington 212 (1915) 193.

This ubiquitous medusa of oriental waters is here reported from Manila Bay for the first time where it appears to be present

at frequent intervals but in small numbers. Two specimens collected by Doctor Shaw at Pasay beach in June, 1918, agreed with my description (1914).

Genus **LOBONEMA** Mayer, 1910

Lobonema mayeri Light.

Lobonema mayeri LIGHT, Philip. Journ. Sci. § D 9 (1914) 217, figs. 7–9.

This specific name was given in 1914 to a medusa common in Malampaya Sound, Palawan, in May, 1913, which differed in several important points from *L. smithii* as described by Mayer from Manila Bay in 1910. These differences combined with the different habitat seemed to make it certain that the two were distinctly different regional species, although I had not had the opportunity of examining specimens of *Lobonema* from Manila Bay.

On examining *Lobonema* from Manila Bay in 1918 I was greatly surprised to find that it agreed in all important details with my description of *L. mayeri* rather than with Mayer's *L. smithii* as I had expected.

The question at once arises, Are these the same species or separate ones? Unfortunately, this question cannot be answered until after a careful reëxamination of the type and comparison with specimens of *Lobonema mayeri,* and perhaps not definitely then.

I am inclined to believe, however, that the characters which seemed to mark *Lobonema smithii* as distinctly different from *L. mayeri* were due to a great extent to the condition of the material from which the diagnosis was made. Mayer's description was based on a "quadrant" of a perfect specimen, and two imperfect specimens. The chief outstanding difference between the two species was that *L. smithii* had but 8 sense organs while *L. mayeri* has from 12 to 16, usually about 14. This may be accounted for by Mayer's "quadrant" having been less than one-fourth of the entire medusa and also by its having been that part of the bell in which the sense organs were least numerous, for the distribution of sense organs is often unsymmetrical. In a number of specimens I have seen two sense organs nearly side by side, giving the appearance of having arisen by fission. This difference in the number of sense organs could not be due to the immaturity of Mayer's specimens since several specimens less than half as large as his showed 14 sense organs. While, therefore, I believe that *Lobonema smithii* and *L. mayeri* are probably the same species, or at most varieties, I have no scientific

basis for reducing *L. mayeri* and we must await a reëxamination of the type to settle this unpleasant tangle. It was to avoid another such situation that I refrained from giving a new specific name to our common Manila Bay *Cotylorhizoides.*

Lobonema mayeri is one of the commonest jellyfishes of Manila Bay, being present at intervals from May to September of every year, and perhaps at other times. It is the largest, most striking, and most beautiful jellyfish of the bay.

Its colors vary between wide limits. Some specimens are uniform opaque white; others show increasing amounts of pink and purple in gonads and mouth arms. The Manila Bay specimens never seem to reach the brilliance of color characteristic of those of Malampaya Sound. Several specimens were noted, however, in which the peripheral canal system was picked out in deep purplish blue.

The very thin stomach floor protrudes from the subgenital ostia in life. The tentacle-like lappets are entirely noncontractile. The bell is somewhat less than a hemisphere in relaxation, and considerably more than a hemisphere in contraction. The lappets undergo continuous beating movements due to the alternate contraction and relaxation of the bell. At complete relaxation they lie extended backward over the upper part of the mouth arms. On contraction of the bell they are drawn forward and inward, and on relaxation are thrown outward and finally come to rest extended backward as before.

The little Carangid fishes are always present in great numbers in and around these medusæ apparently suffering no harm from the heavily armed mouth-arm appendages. The mouth arms (in the region of the mouths, and mouth-arm filaments) are able to administer a most unpleasant but not serious sting. It raises a welt, white at first, later becoming red, which disappears in a short time, a few hours at the most. The arm clubs, which are rather large, are invisible in the water.

Lobonema smithii Mayer, 1910.

Lobonema smithii MAYER, Medusae of the World 3 (1910) 688, figs. 417, 418; Pub. Carnegie Inst. Washington 212 (1915) 196.

As stated above, this species was based on material from Manila Bay collected by the *Albatross.* Since then no specimens agreeing with Mayer's description have been found and it seems probable, for reasons given above, that there is a single species of *Lobonema, L. smithii,* the diagnosis of which would therefore be changed to admit the forms described by me under the name *L. mayeri.*

Rhizostomata lorifera Vanhöffen, 1888

Genus **THYSANOSTOMA** L. Agassiz, 1862

Thysanostoma thysanura Haeckel.

Thysanostoma thysanura HAECKEL, System der Medusen (1880) 625, taf. 39, figs. 1–9. MAYER, Medusae of the World 3 (1910) 692, fig. 420; Pub. Carnegie Inst. Washington 212 (1915) 197.

This medusa is known from Manila Bay from two perfect specimens collected by Dr. Shaw, one in the summer of 1919, and the other in July of 1920. They agree closely with Mayer's description in "Medusae of the World."

ILLUSTRATIONS

[Drawings by M. Ligaya.]

TEXT FIGURES

FIG. 1. A sense organ of *Anomalorhiza shawi* gen. et sp. nov., as seen from the subumbrellar side showing the subumbrellar shelf. × 6.

2. A quadrant of *Anomalorhiza shawi* gen. et sp. nov. in subumbrellar view, showing canal system, subgenital ostium, etc. × 1.

3. *Anomalorhiza shawi* gen. et sp. nov. × 0.5. Two mouth arms have been cut away in front. (The specimen was very much relaxed and the bell is much deeper in life.)

4. Immature individual of *Cotylorhizoides pacificus* (Mayer). Natural size.

NEW PHILIPPINE MORACEAE

By Elmer D. Merrill

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The present paper consists chiefly of the descriptions of twenty-two presumably new species of Moraceae, although notes on a few previously described forms are included. Of the new species two belong in the genus *Artocarpus*, one in *Conocephalus*, one in *Cudrania*, and the remainder in the genus *Ficus*. *Artocarpus superba* Becc., previously known only from Borneo, is here recorded from Mindanao and Basilan, while the genus *Gymnartocarpus* is first credited to the Archipelago by the transfer to it of *Artocarpus woodii* Merr. *Ficus crininervia* Miq. is recorded for the first time from the Archipelago.

ARTOCARPUS Forster

ARTOCARPUS ACUMINATISSIMA sp. nov.

Arbor circiter 10 m alta, plus minusve hirsuta; foliis oblongis, chartaceis, integris vel sursum minute denticulatis, usque ad 35 cm longis, basi leviter cordatis, apice longissime tenuiter caudato-acuminatis, nervis utrinque circiter 20, subtus perspicuis; receptaculis laevis, ovoideis, saltem 3.5 cm diametro, anthocarpiis planis, indistinctis, seminibus subglobosis, circiter 1 cm diametro.

A tree, about 10 m high, the branchlets, petioles, and lower surfaces of the leaves distinctly hirsute with short, spreading, more or less scattered hairs. Branches dark-brown, glabrous, the ultimate ones 4 mm in diameter or less. Leaves oblong, equilateral, chartaceous, 30 to 35 cm long, 9 to 12 cm wide, entire, or distantly and minutely denticulate in the upper part, base rounded distinctly but slightly cordate, apex very long caudate-acuminate, the acumen up to 4 cm long, acute, the upper surface brown and shining when dry, glabrous except the more or less pubescent midrib; petioles about 1 cm long. Receptacles axillary, solitary, ovoid, at least 3.5 cm in diameter, the peduncles 6 to 7 cm long. Anthocarps numerous, but few maturing seeds, their tips plane, indistinct, less than 1 mm in diameter, forming a smooth fruit. Seeds subglobose, about 1 cm in diameter.

LUZON, Tayabas Province, Hinobaan, *For. Bur. 22777 DeMesa & Rosario,* September 28, 1913, in dense forests, altitude 240 meters, locally known as *cubi.*

A very characteristic species at once distinguished from all other Philippine forms by its vegetative characters and its ample, entire or but obscurely denticulate, long caudate-acuminate, equilateral leaves, which are cordate at the base and hirsute on the lower surface.

ARTOCARPUS PINNATISECTA sp. nov.

Arbor alta, ramulis stipulisque exceptis glabra; foliis circiter 50 cm longis, pinnatisectis, coriaceis, segmentis lanceolatis, acuminatis, circiter 20 cm longis; inflorescentiis ♂ cylindraceis, axillaribus, solitariis, circiter 10 cm longis, 3 cm diametro; stipulis coriaceis, 20 ad 26 cm longis, extus dense ciliato-villosis; fructibus cylindraceis.

A tall tree, glabrous except the younger parts and the stipules, the ultimate branchlets terete, very stout, 1.5 to 3 cm in diameter, dark reddish-brown, marked with prominent petiolar and stipular scars, ciliate-bearded below the petioles and stipules, otherwise glabrous. Leaves oblong to oblong-ovate in outline, about 50 cm long, nearly glabrous, coriaceous, pinnately divided into about 15 segments, the sinuses narrow, extending nearly or quite to the midrib, the segments lanceolate, entire, sharply acuminate, straight or somewhat falcate, ascending, about 20 cm long, 1.5 to 3 cm wide, the midrib and nerves somewhat pubescent; petioles very stout, 10 to 12 cm long; stipules lanceolate, coriaceous, 20 to 26 cm long, acuminate, inside brown and glabrous, outside rather densely ciliate-villous with long, rather soft, shining, brownish or grayish hairs. Staminate inflorescence axillary, solitary, cylindric, about 10 cm long, 3 cm in diameter, rounded at both ends, the peduncles stout, 3 to 4 cm long, glabrous or somewhat ciliate-villous. Immature fruits cylindric, about 15 cm long, 4 cm in diameter, the tips of the anthocarps ovoid, about 2 mm long and 1.5 mm wide, blunt, densely verruculose.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 20789 Escritor* (type), March 9, 1913; Camarines Province, Paracale, *Bur. Sci. 33536 Ramos & Edaño.* MINDANAO, Davao Subprovince, *For. Bur. 27751 Cruz.*

A very striking species in the group with *Artocarpus communis* Forst., characterized by its long, ciliate-villous stipules and especially by its pinnately divided leaves, the numerous, narrow, lanceolate segments, and the equally narrow sinuses which extend quite or nearly to the midrib.

ARTOCARPUS SUPERBA Becc. Nelle Foreste di Borneo (1902) 625.

MINDANAO, Zamboanga Subprovince, mountains back of Zamboanga, *Merrill 8280*, December 6, 1911, in forests, altitude about 400 meters; Port Banga, *For. Bur. 9164 Whitford & Hutchinson.* BASILAN, *For. Bur. 3989 Hutchinson.*

A very interesting addition to the rather meager list of species known only from the Philippines and Borneo. Although the Mindanao specimens are sterile, there appears to be no doubt as to the identity of the Bornean and Philippine plants. So far as the material goes, it agrees with Beccari's description, and with specimens from Sarawak in the herbarium of the Bureau of Science, *Foxworthy 344*. The local name is given as *pikpikuag* (Sulu).

CONOCEPHALUS Blume

CONOCEPHALUS MOLLIS sp. nov.

Frutex scandens subtus foliis molliter pubescens; foliis oblongis, integris, late oblongis, usque ad 27 cm longis, basi rotundatis, apice acutis vel acuminatis, nervis utrinque circiter 15, subtus dense pubescens, supra cystolithis numerosissimis instructis; inflorescentiis ♂ diffusis, dichotomis, usque ad 27 cm latis, capitulis numerosis, 4- ad 6-floris.

A scandent shrub, the ultimate branches about 1.5 cm in diameter, the young branchlets, inflorescences, and especially the lower surfaces of the leaves softly pubescent. Leaves chartaceous, broadly oblong, about 27 cm long, 16 cm wide, entire, base rounded, apex acute to acuminate, dull, of the same color, and greenish-olivaceous on both surfaces when dry, the lower surface softly and densely pubescent, the upper surface uniformly and densely covered with cystoliths, the cystoliths scattered and radiate; lateral nerves about 15 on each side of the midrib, prominent; petioles about 8 cm long. Male inflorescences axillary, solitary, diffuse, repeatedly dichotomous, in anthesis up to 27 cm wide, short-peduncled, pubescent with scattered hairs, the very young ones with numerous, concave, imbricate, pubescent bracts about 1 cm in diameter. Male flowers numerous, all sessile, borne on the ultimate branchlets, usually a solitary sessile flower at the ultimate fork, with two lateral, peduncled heads of from 4 to 6 flowers each. Perianth about 1.7 mm long, 4-toothed or lobed. Stamens 4, about 2 mm long, the anthers erect in bud.

SAMAR, Ambalete, *Bur. Sci. 17582 Ramos*, April 7, 1914, in damp forests, the flowers white.

A very characteristic species, at once distinguished by its leaves being softly and densely pubescent on the lower surface,

the upper surface being densely and uniformly covered with radiate and scattered cystoliths; its very diffuse, repeatedly dichotomous male inflorescences; and the peculiar disposition of the flowers, a solitary sessile one at each ultimate fork, the others in small few-flowered heads.

CUDRANIA Trécul

CUDRANIA GRANDIFOLIA sp. nov.

Frutex scandens, glaber, vel ramulis junioribus leviter adpresse pubescens; foliis chartaceis vel subcoriaceis, ellipticis, usque ad 15 cm longis, breviter acuminatis, basi acutis ad rotundatis, nervis utrinque 6 ad 8, perspicuis; fructibus globosis, densissime puberulis, in siccitate 1 ad 2 cm diametro.

A scandent glabrous shrub, or the younger branchlets sparingly appressed-pubescent. Branches terete, in the specimens examined unarmed, pale-brownish, shining, minutely lenticellate. Leaves chartaceous to subcoriaceous, elliptic, olivaceous, somewhat shining, the larger ones up to 15 cm long and 8 cm wide, the lower surface paler than the upper, apex rather prominently acuminate, the acumen often short, abrupt, base acute to rounded; lateral nerves 6 to 8 on each side of the midrib, prominent, curved-ascending, anastomosing, the reticulations distinct; petioles 1.5 to 2 cm long. Fruits globose, axillary, solitary or in pairs, when dry 1 to 2 cm in diameter, their peduncles 5 mm long or less, grayish-brown when dry, densely and uniformly puberulent.

MINDANAO, Surigao Province, Placer, *Wenzel 1883*, July 11, 1916, in forests, altitude about 150 meters.

A species manifestly allied to *Cudrania javanensis* Tréc., from which it is distinguished by its much larger leaves.

GYMNARTOCARPUS Boerlage

GYMNARTOCARPUS WOODII (Merr.) comb. nov.

Artocarpus woodii Merr. in Philip. Journ. Sci. 3 (1908) Bot. 221; Elm. Leafl. Philip. Bot. 2 (1909) 623.

This species is manifestly referable to the genus *Gymnartocarpus*, in which it is here placed, and is very closely allied to the Javan *G. venenosa* (Zoll.) Boerl., the type of the genus.[1] In fact, a critical examination of a large series of Javan and Philippine specimens may show that the two species are identical. I have

[1] Ic. Bogor. 1 (1897) 73, *t. 25, 26.*

not only the descriptions and figures of *Gymnartocarpus venenosa* (Zoll.) Boerl., but also botanical specimens with immature capitula and with portions of a mature fruit, from specimens cultivated in the Botanical Garden at Buitenzorg. The Philippine material seems to differ constantly in its longer-peduncled capitula, its sharply acuminate leaves, not acuminate and retuse as in the Javan specimens. *Gymnartocarpus woodii* is represented by the following material:

LUZON, without definite locality, *Loher 6946:* Cagayan Province, *For. Bur. 6650 Klemme:* Zambales Province, *For. Bur. 6080 Aguilar; For. Bur. 6331 Curran:* Bataan Province, *For. Bur. 12942 Alvarez, For. Bur. 17584, 17599 Curran:* Laguna Province, *For. Bur. 11993, 15382 Tamesis, Bur. Sci. 12392 McGregor, For. Bur. 11652 Whitford:* Camarines Province, *Ahern 41, 281.* MINDORO, Mount Halcon, *Merrill 5557, For. Bur. 8763, 8783 Merritt.* LEYTE, *Bur. Sci. 15184 Ramos.* BUCAS, *Merrill 5259* (type).

The species is known in Laguna as *anubing-cagyos* and *anubing-na-nangca;* in Bataan as *malananca* and *sulipa;* in Zambales as *pongi;* and in Cagayan as *buratu.* There is no record that the sap is at all poisonous.

FICUS Linnaeus

FICUS ELLIPTIFOLIA sp. nov. § *Urostigma.*

Arbor circiter 15 m alta, ramulis receptaculisque exceptis glabra; foliis ellipticis, coriaceis, utrinque rotundatis, usque ad 12 cm longis, petiolatis, nervis utrinque circiter 7, subtus perspicuis; receptaculis axillaribus, sessilibus, solitariis, ebracteatis, ellipsoideis, 3.5 ad 4 cm longis, extus perspicue adpresse setoso-hirsutis.

A tree, nearly glabrous, the branches terete, wrinkled when dry, pale reddish-brown, glabrous, the branchlets more or less appressed-hirsute with stiff brownish hairs. Leaves alternate, elliptic, coriaceous, rather pale when dry, 9 to 12 cm long, 4.5 to 6 cm wide, entire, usually subequally rounded at both ends, or the base somewhat narrowed, the apex sometimes merely blunt; lateral nerves about 7 on each side of the midrib, prominent on the lower surface, looped-anastomosing, the ultimate reticulations rather dense; petioles 1.5 to 2.5 cm long. Receptacles axillary, solitary, sessile, ellipsoid, 3.5 to 4 cm long, about 2 cm in diameter, coarsely wrinkled when dry, umbilicus prominent at the apex, base somewhat narrowed, outside with appressed, brownish-yellow, shining, stiff, long, bristle-like hairs, the bracts none or very early deciduous.

MINDANAO, Zamboanga Subprovince, *Copeland s. n., For. Bur. 9309 Whitford & Hutchinson* (type), January, 1908, in forests, altitude 30 meters.

A species manifestly closely allied to *Ficus cucurbitina* King of Borneo and Celebes, but with somewhat smaller fruits and very differently shaped leaves. A specimen from Mount Maquiling with smaller and bracteate fruits may prove to be the same species (*Villamil s. n.*).

FICUS HALLIERI sp. nov. § *Urostigma.*

Arbor alta, receptaculis exceptis glabra; foliis coriaceis, oblongis ad oblongo-ellipticis, laevis, usque ad 18 cm longis, acuminatis, integris, basi acutis vel subacutis, nervis utrinque circiter 12, subtus perspicuis; receptaculis axillaribus, solitariis vel binis, longe pedunculatis, globosis, extus plus minusve ferrugineo-hirsutis, circiter 3 cm diametro, basi 3-bracteatis, bracteis triangulari-ovatis, acutis, circiter 4 mm longis.

A tall tree, glabrous except the receptacles. Branches terete, pale or brownish when dry, much wrinkled, 3 to 6 mm in diameter. Leaves alternate, smooth, coriaceous, dark-brownish when dry, 13 to 18 cm long, 4 to 8 cm wide, oblong to oblong-elliptic, entire, rather prominently acuminate, base acute or subacute, obscurely 3-plinerved, the lateral nerves about 12 on each side of the midrib, prominent on the lower surface, spreading, anastomosing; petioles 2.5 to 3.5 cm long. Receptacles axillary, solitary or in pairs, globose, about 3 cm in diameter, brown, outside somewhat ferruginous-hirsute, the pubescence more or less deciduous; peduncles about 4 cm long, prominently ferruginous-pubescent, bearing at the apex three, pubescent, triangular-ovate, acute, about 4 mm-long bracts.

MINDANAO, Zamboanga Subprovince, San Ramon, *Hallier s. n.*, February, 1904; Surigao Province, *Bur. Sci. 34357 Ramos & Pascasio.*

This species has already been considered twice by Mr. Elmer [2] but not described, or at least only partly described. He refers to *Ficus hallieri* his *No. 10142* from Negros, which I have not seen, and *No. 11080* from Mindanao, which is probably identical with the type, although in our material the receptacles of the latter number are apparently quite glabrous. The species is manifestly in the *F. chrysolepis* group, but is readily recognizable by its globose, long-peduncled, more or less ferruginous-pubescent receptacles.

[2] Leafl. Philip. Bot. 2 (1909) 536; 4 (1911) 1243.

FICUS BALETE sp. nov. § *Urostigma.*

Arbor glabra, usque ad 15 m alta; foliis alternis, crasse coriaceis, ellipticis ad oblongis vel obovato-oblongis, integris, apice breviter late obtuseque acuminatis, basi acutis ad rotundatis, petiolatis, nervis primariis utrinque circiter 12 quam secundariis vix magis distinctioribus; receptaculis axillaribus, solitariis, pedunculatis, oblongo-ovoideis ad ellipsoideis, glabris, circiter 1.5 cm longis, bracteis 3, perspicuis, late ovatis, obtusis, patulis, circiter 6 mm longis.

A glabrous tree, starting as an epiphyte and soon strangling its host, reaching a height of about 15 m, the branches terete, yellowish-brown, wrinkled, the ultimate ones about 5 mm in diameter, marked with scars of fallen petioles and stipules. Leaves alternate, thickly coriaceous, 7 to 13 cm long, 3 to 6 cm wide, elliptic to oblong-elliptic or oblong-obovate, brownish or olivaceous when dry, somewhat shining, entire, the apex shortly, broadly, and obtusely acuminate, the base acute to rounded, somewhat 3-plinerved; primary lateral nerves about 12 on each side of the midrib, rather prominent but scarcely more distinct than are the secondary nerves, the reticulations distinct, all anastomosing in a submarginal nerve; petioles 1.5 to 2.5 cm long; stipules lanceolate, acuminate, coriaceous, brown, 2.5 cm long. Receptacles axillary, solitary, glabrous, red when mature, but little wrinkled, hard, oblong-ovoid to ellipsoid, rounded at the apex, 1.5 to 1.8 cm long, 1 to 1.3 cm in diameter, the base with three, broadly ovate, obtuse, coriaceous, persistent, spreading, brown, glabrous bracts about 6 mm long, the peduncles about 8 mm long.

LUZON, Zambales Province, *Merrill 2931,* May, 1903, *Hallier s. n.:* Rizal Province, Antipolo, *Merrill 1732,* March, 1903, *Bur. Sci. 22246 Ramos:* Laguna Province, Mount Maquiling, *For. Bur. 26449 Catalan, For. Bur. 20124 Forestry School,* March, 1913, *Elmer 18266:* Tayabas Province, Guinayangan, *Merrill 2033* (type), *2041,* April, 1903, *Bur. Sci. 20869 Escritor,* March, 1913, *Bur. Sci. 26878 Edaño:* Camarines Province, *Ahern 193, 23.* MINDORO, *For. Bur. 8535 Merritt,* January, 1908. PANAY, *Copeland 131,* January, 1904, *Bur. Sci. 31516 Ramos & Edaño.*

A species, widely distributed in the northern Philippines at low altitudes, well characterized by its medium-sized, short-peduncled receptacles which have three prominent, spreading bracts at the base. It is commonly known as *balete,* but this native name is applied to many other species of the section *Urostigma.*

FICUS LAMAOENSIS sp. nov. § *Urostigma.*

Arbor alta, glabra; foliis coriaceis, oblongis ad oblongo-ellipticis, petiolatis, laevis, usque ad 18 cm longis, late breviter obtuseque acuminatis, basi subacutis ad rotundatis, nervis utrinqe circiter 9, distinctis; receptaculis globosis, sessilibus, circiter 1 cm diametro, basi 3-bracteatis.

A tall tree, quite glabrous, reaching a height of at least 25 m, the branches terete, grayish or reddish-brown when dry, wrinkled, 4 to 5 mm in diameter. Leaves alternate, oblong to oblong-elliptic, coriaceous, 12 to 18 cm long, 5 to 7 cm wide, entire, apex shortly, broadly, and obtusely acuminate, base subacute to rounded; lateral nerves about 9 on each side of the midrib, prominent on the lower surface, anastomosing, the reticulations distinct; petioles 2.5 to 3 cm long. Receptacles axillary, solitary, sessile, globose, orange-yellow when mature, about 1 cm in diameter, the basal bracts three, broadly ovate, about 3 mm long.

LUZON, Bataan Province, Lamao River, *For. Bur. 2483* (type), *2369 Borden,* January, 1905, *For. Bur. 2316 Meyer,* December, 1904, on forested ridges, altitude about 200 meters.

A species in the group with *Ficus benjamina* Linn., but with larger leaves and receptacles and strongly differentiated nerves, the primary ones being distant and much more prominent than are the reticulations.

FICUS BRUNNEA sp. nov. § *Synoecia.*

Frutex glaber 2 ad 3 m altus; foliis chartaceis vel subcoriaceis, in siccitate brunneis, lanceolatis ad oblongo-lanceolatis, usque ad 13 cm longis et 2.5 cm latis, integris, utrinque subaequaliter angustatis, apice acuminatis, basi acutis, nervis utrinque 9 ad 16; receptaculis axillaribus, globosis, laevis, breviter pedicellatis, circiter 1 cm diametro.

A glabrous shrub, 2 to 3 m high, the branches terete, pale brownish-gray, slender, smooth. Leaves alternate, lanceolate to oblong-lanceolate, 5 to 13 cm long, 1 to 2.5 cm wide, subequally narrowed to the acute base and to the acuminate apex, entire, smooth, glabrous, brownish and of about the same color on both surfaces and slightly shining when dry, chartaceous to subcoriaceous; lateral nerves 9 to 16 on each side of the midrib, distant, spreading, not very prominent, anastomosing, the reticulations obscure; petioles 5 to 12 cm long; stipules lanceolate or linear-lanceolate, acuminate, about 1 cm long. Receptacles axillary, solitary, globose, smooth, about 1 cm in diameter, the

peduncles about 3 mm long, stout, thickened upward, and with three broadly ovate-subreniform bracts at the apex about 1.2 mm in length. Male flowers only near the orifice; stamens 1, the anthers 0.8 mm long. Gall flowers numerous, sessile to pedicelled, the ovaries ellipsoid, 1.2 to 1.5 mm long when mature.

SAMAR, Yabong, *Phil. Pl. 1605 Ramos,* April, 1914, on forested slopes; Catubig River, *Bur. Sci. 24338 Ramos,* March, 1916.

A species characterized by its brownish, rather narrow leaves which are subequally and gradually narrowed at both ends. It remotely resembles *Ficus philippinensis* Miq., but is entirely distinct from that species.

FICUS APPENDICULATA sp. nov. § *Covellia.*

Arbor usque ad 10 m alta, glabra; foliis alternis, chartaceis, ellipticis ad oblongo-obovatis, 10 ad 20 cm longis, basi rotundatis ad acutis admodum plus minusve inaequilateralibus, apice acuminatis, nervis utrinque 8 ad 10, conspicuis; inflorescentiis caulinis, e tuberculis magnis usque ad 3 cm diametro, vel ramosis, ramis paucis vel numerosis, crassis, usque ad 4 cm longis, cicatricibus magnis instructis; receptaculis numerosis, obovoideis ad depresso-globosis, in siccitate usque ad 2.5 cm diametro, pedunculatis, partibus superioribus bracteis 3 perspicuis, distantibus triangulariter dispositis instructis.

A tree, up to 10 m high, glabrous or nearly so throughout. Leaves alternate, chartaceous, elliptic to oblong or somewhat oblong-obovate, usually brownish when dry, 10 to 20 cm long, 4 to 10 cm wide, the base broadly rounded to acute, sometimes more or less inequilateral, the apex rather distinctly acuminate, the margins entire to undulate or obscurely and irregularly toothed; lateral nerves 8 to 10 on each side of the midrib, conspicuous; petioles 1.5 to 3 cm long; stipules lanceolate, acuminate, deciduous, about 1.5 cm long. Inflorescences cauline and on the larger branches, the receptacles numerous, green, borne on very large, stout tubercles up to 3 cm in diameter or the inflorescences composed of few to many, very stout branches up to 4 cm in length, these marked with numerous large conspicuous scars of fallen peduncles. Receptacles numerous, obovoid to depressed-globose, when young somewhat pubescent, glabrous at maturity, brown, conspicuously rugose when dry and up to 2.5 cm in diameter, when fresh green and apparently about 4 cm in diameter, the apical portion with a conspicuous triangular area varying from 1 to 2 cm in diameter and marked by the coriaceous, somewhat spreading, broadly triangular bractlike appendages

at the corners of the triangle, these appendages quite distinct from the areolar bracts; peduncles up to 2.5 cm long, each supplied at the apex with 3 triangular-ovate, acute bracts about 3 mm long. Fertile female flowers only in one set of receptacles, numerous, their pedicels up to 2 mm long; ovary obovoid, inequilateral, about 1.5 mm long; style about as long as the ovary. Male flowers only near the orifice in certain receptacles, about 2.5 mm long, their perianth segments obovate to oblong-obovate, about 1.5 mm in length.

SAMAR, Catubig River, *Sablaya 1* (type), *Bur. Sci. 24429 Ramos*, February and March, 1916. MINDANAO, Surigao Province, *Bur. Sci. 34465 Ramos & Pascasio*, April 29, 1919, in damp forests at low altitudes, known to the Visayans of Samar as *tuyokay na digtoy* and as *tubog*.

A species of the section *Covellia* well characterized by its large, cauline tubercles or the very stout, short, prominently scarred branches of the infructescence and especially by bractlike appendages on the upper part of the receptacles, these forming a conspicuous triangular area surrounding but distinct from the apical areola.

FICUS MIRABILIS sp. nov. § *Covellia*.

Arbor parva, partibus junioribus plus minusve ciliato-hirsutis; foliis alternis, obovatis, usque ad 18 cm longis, scabris, brevissime acuminatis, basi angustatis, obtusis; inflorescentiis in ramis specialibus, simplicibus, e trunco oriundis, usque ad 3.3 m longis; receptaculis paucis, solitariis, depresso-globosis, 1.5 ad 2 cm diametro, sessilibus, extus perspicue brunneo-ciliato-setosis.

A small tree, the younger parts more or less ciliate-hirsute with stiff, dark-brown, long, straight hairs. Branches terete, more or less ciliate-hirsute, the younger parts rather densely so. Leaves alternate, obovate, 15 to 18 cm long, 7 to 9 cm wide, scabrid on both surfaces, slightly hirsute, becoming nearly glabrous, shortly and sharply acuminate, margins subentire or entire, base narrowed, obtuse, the lower surface puncticulate, paler than the upper; lateral nerves about 6 on each side of the midrib, prominent on the lower surface; petioles 1 to 1.5 cm long, brown-ciliate; stipules oblong, 1.5 cm long, chartaceous. Inflorescence from the trunk, simple, greatly elongated, either pendulous or spreading on the ground from the base of the tree, emitting rootlets, the whole inflorescence up to 3.3 m long, brown, terete, 5 mm in diameter, the younger parts with scattered, stiff,

brown hairs and with numerous, chartaceous, ovate, obtuse, brown-setose bracts 1 cm long or less. Receptacles few and only near the end of the inflorescence, depressed-globose, sessile, 1.5 to 2 cm in diameter, covered with brown, stiff, shining, elongated hairs.

LUZON, Laguna Province, San Antonio, *Bur. Sci. 20395 Ramos*, February, 1913 (type): Camarines Province, Paracale, *Bur. Sci. 33490 Ramos & Edaño*, December, 1918: Bontoc Subprovince, *Vanoverbergh 3970, 1354.*

A species to be compared with *Ficus geocarpa* Teysm., remarkable for its elongated, unbranched, specialized infructescences which spread on the ground from the base of the trunks. In vegetative characters it is very distinct from Teysmann's species as figured by King.

FICUS CONFERTIFOLIA sp. nov. § *Eusyce.*

Frutex erectus, circiter 3 m altus, glaberrimus, multiramosus; foliis confertis, coriaceis, oblongis ad oblongo-ovatis, integris, usque ad 3.5 cm longis, in siccitate pallidis, acutis vel leviter acuminatis, basi acutis, triplinerviis, nervis utrinque 4 ad 6, subtus brunneo-puncticulatis; receptaculis axillaribus, pedunculatis, ovoideis, circiter 6 mm diametro; floribus ♂ diandris.

An erect, entirely glabrous, much-branched shrub about 3 m high, the branches and branchlets stiff, terete, reddish-brown, the bark somewhat papery, the ultimate branchlets somewhat fastigiate. Leaves numerous, crowded on the ultimate branchlets, oblong to oblong-ovate, coriaceous, brittle, 2 to 3.5 cm long, 1 to 1.7 cm wide, entire, brown when dry, slightly shining, apex acute or slightly acuminate, base acute, distinctly 3-plinerved, the primary lateral nerves above the basal pair 4 to 6, slender, spreading, anastomosing, the lower surface brown-puncticulate; petioles 3 to 5 mm long. Receptacles axillary, solitary, ovoid, smooth, brown when dry, about 6 mm in diameter, their peduncles up to 9 mm in length, 3-bracteate at the apex, the bracts small, ovate. Staminate and gall flowers in the same receptacle, both numerous. Staminate flowers pedicellate, the pedicels up to 1.2 mm long, with a conspicuous, ovate, acuminate, 1 mm-long bracteole; perianth segments usually 3, brown, ovate, acuminate, 1 to 1.2 mm long; stamens two, the anthers about 1 mm long. Gall flowers: perianth segments lanceolate, acuminate, somewhat curved, 1.3 mm long, brown; ovary somewhat obovoid, 1.2 mm long; style slender, sublateral.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26307 Ramos & Edaño*, August 22, 1916, in the mossy forest, altitude apparently about 1,000 meters.

This very characteristic species is manifestly allied to *Ficus formosana* Maxim., from which it is distinguished by its numerous, subfastigiate branchlets, and much smaller, coriaceous, fewer-nerved leaves.

FICUS SAMARENSIS sp. nov. § *Eusyce*.

Frutex scandens, partibus junioribus et subtus foliis ad costa nervisque et petiolis ferrugineo-villosis; foliis ovatis ad oblongo-ovatis, coriaceis, usque ad 15 cm longis, tenuiter acuminatis, basi rotundatis, integris, in siccitate brunneis, supra glabris; receptaculis globosis, sessilibus, 6 ad 8 mm diametro, extus parcissime pubescentibus vel glabris.

A scandent shrub, the younger parts, petioles, and leaves on the midrib and lateral nerves beneath more or less subappressed ferruginous-villous. Branches brown, terete, glabrous. Leaves alternate, ovate to oblong-ovate, coriaceous, 8 to 15 cm long, 4 to 6 cm wide, brown when dry, the upper surface glabrous, somewhat shining, the lower surface ferruginous-villous on the midrib and lateral nerves, with much shorter hairs on the reticulations, the apex rather slenderly and sharply acuminate, base rounded; lateral nerves about 6 on each side of the midrib, very prominent on the lower surface, anastomosing; petioles 7 to 14 mm long. Receptacles axillary, somewhat fascicled, sessile, globose or subglobose, 6 to 8 mm in diameter, brown when dry, glabrous or with very few short hairs, each subtended by three, broadly ovate, brown, 1.5 to 2 mm-long bracts. Fertile female flowers numerous, the ovaries oblong-elliptic, about 1.2 mm long; styles terminal, up to 1 mm in length, ovary and style pale in contrast to the brown segments which are oblong and about 1.5 mm in length.

SAMAR, Yabong, *Phil. Pl. 1606 Ramos* (type), March 18, 1914, in damp forests. The collector notes that the fruits also grow on the main stems of the plant. CATANDUANES, *Bur. Sci. 30290 Ramos*.

A species very closely allied to *Ficus lanata* Blume, but with somewhat larger leaves which are not uniformly and densely villous beneath, and sessile, not peduncled fruits. Among the Philippine species it is very close to *Ficus propinqua* Merr., but is less villous and has smaller fruits; from *Ficus ramosii*

Merr., it is entirely different in its indumentum, although in other characters quite similar to this species.

FICUS AHERNII sp. nov. § *Eusyce.*

Frutex scandens, *F. obtusae* Hassk. affine; foliis ovatis ad elliptico-ovatis, usque ad 10 cm longis, apice obtusis vel rotundatis, basi cordatis, margine integris, supra scabris, subtus pubescentibus, nervis utrinque 4 vel 5; receptaculis axillaribus, solitariis, globosis, pedunculatis, circiter 1.5 cm diametro, glabris vel subglabris, bracteis circiter 2 mm longis.

A scandent shrub, the younger parts more or less densely pubescent; branches terete, dark-colored when dry, glabrous, striate, the branchlets densely ferruginous-pubescent; leaves alternate, ovate to elliptic-ovate, coriaceous, entire, 7 to 10 cm long, 4 to 8 cm wide, the apex broadly rounded or obtuse, base distinctly cordate, sometimes merely subtruncate, the upper surface rather pale, scabrid, the lower somewhat similar in color but rather densely pubescent; lateral nerves 4 or 5 on each side of the midrib, prominent; petioles densely brown-pubescent, 1 to 2.5 cm long. Receptacles axillary, solitary, peduncled, globose, glabrous or nearly so, about 1.5 cm in diameter, containing only fertile female flowers so far as examined, the peduncles about 1 cm long, pubescent, bearing at their apices three small, ovate, 2 mm-long bracts.

LUZON, Rizal Province, Bosoboso, *For. Bur. 3104 Ahern's collector,* May, 1908 (type): Sorsogon Province, *Elmer 17022, 14406.* BILIRAN, *Bur. Sci. 18639 McGregor.* SAMAR, *Bur. Sci. 17512, 17568 Ramos.*

This species is manifestly very closely allied to the Malayan *Ficus obtusa* Hassk. It differs from our Javan material (*Koorders 38836*) in its receptacles being glabrous or nearly so, not densely ferruginous-pubescent, and in its much smaller bracts and longer peduncles. It is named in honor of Major G. P. Ahern, formerly Director of the Bureau of Forestry.

FICUS OBTUSA Hassk. Cat. Hort. Bogor. (1844) 75; King in Ann. Bot. Gard. Calcutta 1 (1888) 130, *t. 163.*

LUZON, Laguna Province, Mount Maquiling, *For. Bur. 26749 Maiesa, For. Bur. 20212 Villamil,* February, 1917, and May, 1913. In forests, ascending to 400 meters.

A species widely distributed in the Malay Peninsula and Archipelago, but not previously recorded from the Philippines. The specimens agree with the description and with our Javan material representing it. *Ficus ahernii* Merr., is closely allied.

FICUS EDAÑOI sp. nov. § *Eusyce.*

Frutex suberectus, ramulis junioribus leviter pubescens, cortex tenuiter papyraceis, deciduis; foliis subcoriaceis, oblongis, 5 ad 9 cm longis, obtusis, basi obtusis et plerumque leviter cordatis vel auriculatis, nervis utrinque 6 ad 8, perspicuis, brunneo-glandulosis vel punctatis; receptaculis solitariis, pedunculatis, ovoideis, glabris, circiter 8 mm longis, pedunculo 10 ad 12 mm longo, bracteis apicalibus 3, triangulari-ovatis, acuminatis, 1.5 mm longis.

An erect or spreading shrub, the young branchlets and pedicels somewhat pubescent, otherwise glabrous, the branches and branchlets terete, the bark thin, papery, the outer layers loose, soon becoming detached in thin flakes. Leaves subcoriaceous, oblong, 5 to 9 cm long, 2 to 3.5 cm wide, rather pale when dry, the apex obtuse, base obtuse and usually slightly cordate or auriculate, the margins entire or obscurely undulate, both surfaces smooth, the nerves 6 to 8 on each side of the midrib, brown in contrast to the pale lower surface, conspicuous, anastomosing, the reticulations distinct, under a lens distinctly brown-glandular or punctate; petioles 5 to 8 mm long; stipules deciduous, linear-lanceolate; slenderly acuminate up to 12 mm long. Receptacles axillary, solitary, ovoid, glabrous, about 8 mm long, brown when dry, their peduncles 10 to 12 mm in length, somewhat pubescent, supplied at the apex with three, triangular-ovate, acuminate, slightly pubescent bracts, about 1.5 mm long.

LUZON, Tayabas Province, near Mount Tulaog, *Bur. Sci. 29130 Ramos & Edaño,* May 23, 1917, spreading on rocks near the sea.

The alliance of this species is apparently with *Ficus mearnsii* Merr., from which it differs notably in its entirely differently shaped leaves.

FICUS HAGGERI sp. nov. § *Eusyce.*

Arbor circiter 20 m alta, glabra vel foliis minute scaberulis; foliis ovatis ad late elliptico-ovatis, leviter inaequilateralibus, usque ad 20 cm longis, integris breviter acuminatis, basi leviter oblique cordatis, nervis utrinque circiter 8; receptaculis axillaribus et e axillis defoliatis, solitariis vel binis, pedunculatis, globosis, circiter 1 cm diametro, glabris vel minute scaberulis, basi 3-bracteatis.

A tree, about 20 m high, quite glabrous, or the branchlets and leaves minutely scaberulous. Branches rather slender, terete, reddish-brown. Leaves alternate, ovate to broadly elliptic-ovate, 18 to 20 cm long, 9 to 12 cm wide, entire, apex somewhat acumin-

ate, base somewhat inequilateral and distinctly obliquely cordate, margins entire, when dry both surfaces pale, the upper somewhat shining; lateral nerves about 8 on each side of the midrib, prominent on the lower surface, the reticulations distinct; petioles 1.5 to 2 cm long. Receptacles axillary and in the axils of fallen leaves, solitary and in pairs, globose, pale when dry, glabrous or minutely scabrid, about 1 cm in diameter, the peduncles 6 to 8 mm long bearing three small bracts near the apex; fertile female flowers only observed.

LUZON, Tayabas Province, Guinayangan, *Merrill 2009*, collected by E. Hagger, March 28, 1903, in flat forests along Danlagan River, locally known as *opli:* Laguna Province, Mount Maquiling, *For. Bur. 26036 Mabesa.* LEYTE, *Wenzel 1230.*

A species best recognized by its broad, slightly obliquely cordate leaves which are nearly glabrous or only minutely scabrid. Its alliances are not clear to me.

FICUS SARGENTII sp. nov. § *Sycidium.*

Arbor 6 ad 7 m alta, ramulis et petiolis et foliis utrinque perspicue hispidis; foliis alternis, subcoriaceis, oblongo-ellipticis, 25 ad 30 cm longis, acuminatis, basi late rotundatis, leviter cordatis, distincte inaequilateralibus, nervis utrinque circiter 8, perspicuis; inflorescentiis caulinis, receptaculis e tuberculis parvis vel in ramis crassis confertis dispositis, ramis usque ad 3 cm longis, et 5 ad 11 mm diametro, cicatricibus magnis instructis; receptaculis obovoideis, hispidis, 1 ad 1.4 cm diametro, pedunculo usque ad 12 mm longo.

A tree 6 to 7 m high, the branchlets, petioles and leaves on both surfaces conspicuously hispid. Leaves alternate, subcoriaceous, oblong-elliptic, 25 to 30 cm long, about 15 cm wide, harsh, brittle, the apex somewhat acuminate, base broad, rounded, shallowly cordate, distinctly inequilateral, the margins entire or obscurely toothed; lateral nerves about 8 on each side of the midrib; petioles 2 to 2.5 cm long. Inflorescences cauline, the receptacles from small and unbranched tubercles about 1 cm long or from more or less coarsely branched infructescences up to 3 cm long, the branches short, crowded, very stout, 5 to 10 mm in diameter. Receptacles yellow, obovoid, hispid, 1 to 1.4 cm in diameter, their peduncles up to 12 mm long with 1 or more bracts at the base. Fertile female flowers only observed, these numerous, their ovaries oblong-obovoid, 1 mm long; style about as long as the ovary; subtending bracteoles numerous, oblong-obovate to spatulate, about 2 mm long.

SAMAR, Catubig River, *Sablaya 10,* March 13, 1916, in damp forests at low altitudes; collected for the Arnold Arboretum.

This species is well characterized by its ample, harsh, inequilateral, alternate leaves and its cauline inflorescences. It distinctly resembles *Ficus heteropoda* Miq., from which I am of the opinion that *F. decussata* Warb. and *F. anomala* Merr. are not to be distinguished; the present species is easily distinguished from Miquel's by its alternate leaves which are further different in shape and have much shorter petioles.

FICUS SPARSIFOLIA sp. nov. § *Sycidium.*

Frutex erectus, ramis ramulisque teretibus, tenuibus, glabris; foliis alternis, utrinque scaberulis, lanceolatis ad oblongo-lanceolatis, firmiter chartaceis, usque ad 9 cm longis, perspicue acuminatis, integris, vel obscure undulatis vel interdum basi unilateraliter hastatis, basi plerumque acutis, inaequilateralibus, nervis utrinque circiter 7 perspicuis, anastomosantibus; receptaculis in axillis superioribus minute bibracteatis, solitariis, ovoideis, minutissime scaberulis, circiter 1.5 cm longis, pedunculatis, osteoli bracteolis perspicuis, lanceolatis, acuminatis, erectis, 2.5 ad 3 mm longis, ciliato-hispidis; perigonii laciniis pallidis, glabris, lanceolatis, acuminatis, 2.5 ad 3.5 mm longis.

An erect, branched shrub, 1 m high or more, the branches and branchlets slender, terete, grayish or reddish-brown, glabrous, smooth. Leaves alternate, firmly chartaceous, pale-olivaceous, shining, scaberulous on both surfaces, lanceolate to oblong-lanceolate, 5 to 9 m long, 1 to 1.5 cm wide, prominently and slenderly acuminate, often caudate-acuminate, base usually slightly inequilateral and acute, sometimes prominently hastate on one side and acute on the other, the margins entire or obscurely undulate; lateral nerves about 7 on each side of the midrib, prominent, curved, anastomosing, irregular, the primary reticulations distinct; petioles slender, minutely scabrid, about 5 mm long. Receptacles in the uppermost axils, solitary, ovoid, green, about 1.5 cm in diameter, minutely scabrid, the ostiole surrounded by numerous, erect, lanceolate, acuminate, 2.5 to 3 mm-long, ciliate-hispid bracteoles; peduncles slender, minutely scabrid, about 8 mm long, with two or three small, scattered bracts. Staminate flowers few and only near the ostiole, monandrous, the perianth segments 4, membranaceous, pale, lanceolate, acuminate, 2 to 2.5 mm long, glabrous; anthers 1 mm long. Gall flowers numerous, pedicellate, the pedicels 1.2 mm long, sparingly hispid;

perianth segments 4, pale, membranaceous, lanceolate, acuminate, glabrous, 2.5 to 3.5 mm long. Ovary ovoid-ellipsoid, 1.5 mm in diameter; style lateral, brown, 0.7 mm long.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26492 Ramos & Edaño*, August 3, 1916, in thickets along small streams at low altitudes.

This characteristic species in many respects resembles *Ficus cumingii* Miq., but is distinguished by its smaller, fewer-nerved, alternate leaves and its very conspicuous erect bracteoles about the ostiole. From *Ficus blepharostoma* Warb. it is distinguished by its very differently shaped, much smaller leaves.

FICUS LINEARIS sp. nov. § *Sycidium.*

Frutex circiter 1 m altus, glaber; foliis linearis vel linearilanceolatis, usque ad 10 cm longis et 1 cm latis, rectis vel leviter falcatis, tenuiter acuminatis, laevis, nervis obscuris; receptaculis axillaribus, pedicellatis, depresso-globosis, circiter 1 cm diametro, plus minusve angulatis, extus lenticellatis.

A shrub, about 1 m high, entirely glabrous. Branches terete, reddish-brown, smooth, very slightly wrinkled when dry. Leaves alternate, chartaceous or subcoriaceous, linear or linear-lanceolate, 5 to 10 cm long, 0.5 to 1 cm wide, straight or somewhat falcate, entire, smooth, shining, the apex slenderly acuminate, the base acute or cuneate, subequally narrowed at both ends, lower surface puncticulate; lateral nerves obscure, 10 to 15 on each side of the midrib, obscurely anastomosing, the reticulations obsolete or nearly so; petioles 3 to 5 mm long; stipules lanceolate, acuminate, brown up to 1.5 cm long, deciduous. Receptacles axillary, solitary or in pairs, peduncled, depressed-globose, longitudinally ridged or angled, lenticellate, about 1 cm in diameter, glabrous, the peduncles up to 6 mm in length. Fertile female flowers numerous, sessile or pedicelled, the pedicels up to 1 mm in length; ovary obovoid, 1 to 1.2 mm long; segments very greatly reduced; styles 1 to 1.2 mm long, lateral, sparingly hirsute. Gall and male flowers not seen.

SAMAR, along streams, *Bur. Sci. 17433 Ramos*, April 22, 1914.

A species well characterized by its very narrow, linear or linear-lanceolate leaves. It is manifestly in the same group with *Ficus leucantatoma* Poir., *F. hauili* Blanco, etc., and has the same type of angled or ridged fruits as those species; it is, however, remarkably distinct in its vegetative characters.

FICUS FENICIS sp. nov.

Frutex rigidus, scandens, ramis laevis, ramulis hispidis; foliis alternis, plerumque oblongo-ovatis, coriaceis, rigidis, utrinque perspicue scabridis, integris, 2.5 ad 7 cm longis, obtusis, basi late rotundatis vel leviter cordatis, admodum leviter inaequilateralibus, nervis utrinque 7, distinctis, patulis; receptaculis axillaribus, solitariis, subglobosis, hispido-hirsutus, breviter pedunculatis, 5 ad 6 mm diametro.

A rigid, more or less climbing, much-branched shrub, growing over rocks and cliffs, the branches pale, terete, smooth, the branchlets hispid with short spreading hairs. Leaves alternate, mostly oblong-ovate, coriaceous, rigid, conspicuously scabrid on both surfaces, pale green when dry, entire, 2.5 to 7 cm long, 1.5 to 3.5 cm wide, apex acute to obtuse, the base broad, rounded, or somewhat cordate, often slightly inequilateral; lateral nerves about 7 on each side of the midrib, distinct, spreading, anastomosing, the reticulations rather conspicuous; petioles 3 to 5 mm long, densely hirsute or scabrid when young; stipules 3 to 4 mm long. Receptacles (immature) axillary, solitary, subglobose, 5 to 6 mm in diameter, hispid-hirsute, their peduncles about 2 mm long, subtended by 2 or 3 membranaceous, broadly ovate bracts.

MINDANAO, Bukidnon Province, near Tankulan, *Bur. Sci. 26097 Fénix,* July 13, 1916, scandent over rocks on open hillsides.

In habit and general appearance this species strikingly resembles *Ficus tinctoria* Forst., from which it is at once distinguishable by its conspicuously scabrid leaves, those of Forster's species being very smooth.

FICUS MULTISTIPULARIS sp. nov.

Frutex erectus, partibus junioribus leviter adpresse hirsutis; foliis confertis, chartaceis ad subcoriaceis, oblongo-obovatis, integris, usque ad 28 cm longis, apice abrupte et perspicue acuminatis, deorsum angustatis, basi obtusis, saepe inaequilateralibus, glabris, laevis, nervis utrinque 4 ad 6, adscendentibus, perspicuis; stipulis numerosis, persistentibus, oblongo-ovatis, acuminatis, 2 ad 2.5 cm longis, extus adpresse pubescentibus; receptaculis breviter pedicellatis, axillaribus, solitariis, circiter 12 mm longis, ellipsoideo-ovoideis parce hirsutis.

An erect shrub, about 2 m high *fide* Ramos, the younger parts sparingly hirsute, the backs of the conspicuous persistent stipules densely so. Branches terete, brown, glabrous, about 8 mm in diameter. Leaves opposite, crowded at the apices of the branchlets, firmly chartaceous to subcoriaceous, when dry pale-brownish

above and brown beneath, smooth, glabrous, or the midrib and nerves beneath with a very few appressed hairs, oblong-obovate, often narrowly so, 17 to 28 cm long, 5 to 9 cm wide, entire, the apex abruptly but conspicuously acuminate, the acumen about 1 cm long, blunt, narrowed from the upper three-fourths to the obtuse base, the base 1 to 1.5 cm wide, often inequilateral, sometimes rounded-obtuse on one side and acute on the other; lateral nerves 4 to 6 on each side of the midrib, prominent, ascending, the reticulations distinct, rather close, punctate on the lower surface; petioles 1.5 to 3 cm long, glabrous; stipules numerous, conspicuous, oblong-ovate, persistent, densely appressed-pubescent on the back, narrowed upward, acuminate, 2 to 2.5 cm long. Receptacles axillary, solitary, slightly hirsute, usually distinctly ridged when fresh, brown when dry, ellipsoid-ovoid, about 12 mm long; peduncles up to 4 mm in length, the apical bracts elliptic-ovate, rounded, thick, 3 to 4 mm long. Ostiole conspicuous, up to 6 mm in diameter, the scales reniform, prominent. Fertile female flowers numerous, the ovaries about 1 mm long, the styles 1.5 mm in length. Perianth none.

CATANDUANES, *Bur. Sci. 30270 Ramos* (type), December 9, 1917, in forests along small streams back of Calolbong, at low altitudes. SAMAR, Catubig River, *Bur. Sci. 24412 Ramos,* March, 1916.

This species is well characterized by its leaves and by its conspicuous persistent stipules. I know of no species to which it is closely allied.

FICUS BINUANGENSIS sp. nov.

Arbor circiter 8 m alta, ramulis et petiolis hirsutis, subtus foliis ad costa nervisque plus minusve pubescens; foliis oppositis, membranaceis, oblongo-obovatis, integris, circiter 25 cm longis, acuminatis, nervis utrinque circiter 8, perspicuis; inflorescentiis caulinis, receptaculis in ramis specialibus patulis ramosis circiter 8 cm longis dispositis, ramulis incrassatis, cicatricibus bracteisque multis instructis; receptaculis obovoideis, 1.5 ad 2 cm diametro, leviter hirsutis, pedunculatis, pedunculo 1.5 ad 2.5 cm longo.

A tree, about 8 m high, the branchlets and petioles rather densely hirsute with short hairs, the leaves more or less pubescent beneath on the midrib, nerves, and reticulations, the infructescence cauline. Leaves opposite, equal, membranaceous, oblong-obovate, entire, about 25 cm long and 12 cm wide, the apex rather abruptly acuminate, the acumen about 1 cm in length,

somewhat narrowed below to the rounded base, the upper surface brown, smooth, glabrous, the lower surface paler, the midrib, nerves and reticulations brown in contrast to the paler epidermis; lateral nerves about 8 on each side of the midrib, prominent, curved-ascending, the reticulations distinct; petioles about 2.5 cm long. Receptacles numerous, reddish, somewhat obovoid, rugose when dry and 1 to 2 cm in diameter, probably larger when fresh, sparingly hirsute, borne on specialized thickened branches, cauline; infructescences about 8 cm in length, these infructescences spreading, branched from the base, the ultimate branches about 5 mm in diameter marked with numerous scars of fallen pedicels and toward their apices supplied with numerous, broadly ovate, more or less persistent, coriaceous bracts up to 4 mm in length; peduncles 1.5 to 2.5 cm long, sparingly hirsute, 3-bracteate at the apex, the bracts oblong-ovate, obtuse, about 3.5 mm long. Receptacles containing fertile female flowers only, these very numerous, their pedicels up to 2.5 mm long. Ovary obliquely ovoid to somewhat obovoid, 1.5 mm long; style about as long as the ovary; perianth none or very rudimentary.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28831 Ramos & Edaño,* May 13, 1917, in forests at low altitudes.

It is suspected from the vegetative characters of this species that it belongs in the same section with *Ficus paucinervia* Merr. although it has the infructescence of species belonging in the section *Covellia.*

FICUS FISKEI Elm. Leafl. Philip. Bot. 1 (1906) 195.

This apparently distinct species is of wide distribution in the Philippines, and is represented by the following specimens: LUZON, Ilocos Norte Province, *Bur. Sci. 33042 Ramos:* Rizal Province, *Loher 4917, Bur. Sci. 5207, 4643, 1119, 13745 Ramos:* Laguna Province, *Bur. Sci. 6052 Robinson:* without definite locality, *Vidal 3802, 3816:* Tayabas Province, *Bur. Sci. 19551 Ramos:* Sorsogon Province, *For. Bur. 10547 Curran, Bur. Sci. 23401 Ramos, Elmer 7304.* POLILLO, *Bur. Sci. 6929 Robinson.* LEYTE, *Elmer 7185, 7324* (type number). SAMAR, *Bur. Sci. 17445, 24503 Ramos.* CEBU, *Bur. Sci. 1708 McGregor.* SAMAR, *Piper 353, 370.* MINDANAO, Butuan Subprovince, *Piper 296:* Agusan Subprovince, *Elmer 13315.*

Var. CEBUENSIS var. nov.

A typo differt foliis profunde sinuato-lobatis, receptaculis spinuloso-hispidulis, fasciculatis, in axillis defoliatis, pedunculis longioribus.

CEBU, Guadalupe, in thickets along roadsides, *Bur. Sci. 11086 Ramos*, March, 1912. LUZON, Sorsogon Province, *Elmer 16425*.

In aspect somewhat different from typical *Ficus fiskei*, but apparently not specifically distinct from that species. The leaves are rougher and harsher, somewhat more prominently veined, but differ from those of the species chiefly in being deeply sinuate-lobed. The receptacles are clustered in the axils of fallen leaves, are distinctly spinulous-hispid, and are longer than in typical *Ficus fiskei* Elm.

Var. **LAEVIFOLIA** var. nov.

A typo differt foliis laevis, haud scabridis.

SIARGAO, *Bur. Sci. 35030, 34967 Ramos & Pascasio*, June 1, 1919.

FICUS CRININERVIA Miq. Fl. Ind. Bat. Suppl. (1861) 175, 432; King in Ann. Bot. Gard. Calcutta 1 (1888) 138, *t. 173*.

BASILAN, *Bur. Sci. 13425 Reillo*, August, 1912.

The species is new to the Philippines, its range, according to King, being from Assam through the Malay Peninsula and Archipelago to New Guinea. The Philippine specimen differs from the species as figured and described by King in having some of the receptacles fascicled rather than in pairs. In all essential characters, however, it seems to be quite the same as Miquel's species.

DEUX GENRES NOUVEAUX DE COLÉOPTÈRES (MELASIDÆ)

Par Ed. Fleutiaux

Nogent-sur-Marne, France

Genus **BOTHRION** novum

Allongé, subcylindrique. Tête convexe; épistome rétréci à la base. Antennes pectinées à partir du 3e article. Pronotum arrondi en avant, déprimé à la base. Ecusson convexe. Elytres subparallèles, rétrécis dans le dernier quart, arrondis au sommet, rugueux et striés. Sillons antennaires marginaux, profonds, lisses, nettement limités en dedans par un rebord; bord postérieur des propleures plus court que l'interne; prosternum avec une cavité ronde et profonde à rebords nettement limités, au milieu, en avant et contre les hanches antérieures; saillie prosternale subparallèle, tronquée au sommet. Episternes métathoraciques parallèles, plus étroits que les épipleures des élytres. Hanches postérieures rétrécies en dehors, bord postérieur sinué, bord externe plus large que les épisternes. Dernier segment abdominal arrondi. Pattes grêles; 4e article des tarses échancré en dessus pour recevoir de 5e et dilaté en dessous.

Vient se placer près du genre *Euryaulacus* Bonvouloir; forme générale plus étroite et plus paralléle; élytres moins courts, moins atténués; antennes longuement pectinées.

Bothrion bakeri sp. nov.

Brun-noir avec la base des élytres jaunâtre; pubescence jaune plus apparente à la base du pronotum et des élytres. Tête convexe, à ponctuation ombiliquée très serrée. Epistome aussi large à la base que l'espace compris entre le fond de son échancrure latérale et l'oeil. Antennes noirâtres, dépassant à peine la base du pronotum; 1er article épais, atteignant la moitié de l'oeil; 2e très petit; 3e prolongé latéralement en un rameau deux fois plus long que lui; 4e à 10e plus courts, longuement pectinés; dernier mince et très allongé. Pronotum un peu plus long que large, peu convexe, à ponctuation ombiliquée très serrée. Elytres rugueux, ponctués-striés. Dessous de même couleur. Propectus à ponctuation large et ombiliquée. Métasternum et abdomen à ponctuation serrée mais moins nette. Pattes jaunes; fémurs

noirâtres; 4e article des tarses excavé en dessus et dilaté en dessous.

Longeur, 4 millimètres.

Iles Philippines, Mindanao, Kolambugan (*Baker*).

Genus **ARHAGUS** novum

Court, épais, cylindrique. Tête convexe avec une fossette entre les yeux; épistome rétréci à la base. Antennes longuement pectinées à partir du 3e article; 1er plus épais que les autres, atteignant le bord externe de l'oeil; 2e très court; suivants plus longs. Pronotum aussi long que large, arrondi en avant, sinué latéralement, très convexe, relevé en arrière en bosse sillonnée au milieu, sinué à la base, très rugueusement ponctué; angles postérieurs aigus et dirigés en arrière; carène marginale en bord antérieur brusquement recourbée en arrière au niveau supérieur de l'oeil pour former le tronçon d'une deuxième carène latérale; carène latérale presque entière, interrompue tout près du bord antérieur. Ecusson plan, rétréci en arriére et tronqué. Elytres rétrécis en arrière dans la seconde moitié, arrondis à l'extrémité, densément ponctués, sillonnés de stries peu profondes. Propectus fortement ponctué, sans aucun trace de dépressions antennaires; saillie prosternale graduellement rétrécie. Epipleures des élytres largement arrondis. Episternes métathoraciques étroits, élargis postérieurement. Métasternum et abdomen finement et densément ponctués. Hanches postérieures élargies en dehors. Abdomen convexe; dernier arceau lisse au milieu, rugueux sur les bords, subtronqué au sommet. Pattes grêles: 4e article des tarses lamellé.

Voisin de *Adelothyreus* Chevrolat; en diffère pour sa forme épaisse, son pronotum très convex, l'absence totale de dépressions antennaires.

Arhagus bakeri sp. nov.

Noir mat; pubescence jaune apparente seulement à la base des élytres. Tête densément ponctuée. Epistome aussi large à la base que l'espace compris entre le fond de son échancrure et l'oeil. Antennes noires avec le 2e article ferrugineux, n'atteignant pas la moitié du corps. Pronotum assez fortement, trés densément et rugueusement ponctué. Ecusson finement ponctué. Elytres finement et densément ponctueé, légérement striés. Dessous noir, pubescence jaune trés fine et trés courte. Fémurs noirs; tibias ferrugineux, jaune clair vers le bout; tarses jaunes.

Longeur, 8 millimètres.

Borneo, Sandakan (*Baker*).

DEUX ESPÉCES NOUVELLES DE COLÉOPTÉRES (ELATERIDÆ)

Par Ed. Fleutiaux

Nogent-sur-Marne, France

Melanoxanthus illustris sp. nov.

Allongé, assez large, convexe; pubescence peu apparente. Tête noire, jaune en avant, densément ponctuée. Labre noir. Antennes noires. Pronotum jaune avec quatre points ronds noirs, peu rétréci en avant, arrondi près des angles antérieurs, convexe, déprimé á la base, densément ponctué; angles postérieurs aigus, non divergents, carénés. Ecusson noir, rétréci en arrière, perpendiculaire, convexe et ponctué. Elytres jaunes, avec la suture, les bords latéraux et l'extrémité noirs; la bordure externe est élargie à la base et forme au tiers postérieur une tache arrondie intérieurement s'étendant jusqu'au cinquiéme interstrie; un peu plus étroits que le pronotum, subparallèles, obliquement tronqués á l'extrémité, convexes, légérement et peu densément ponctués, ponctués-striés. Dessous jaune avec le dernier segment abdominal noir, finement ponctué. Sutures prosternales parallèles. Hanches postérieures peu rétrécies en dehors. Pattes jaunes.

Très jolie espèce remarquable pour les quatre points ronds qui ornent le pronotum et le dessin des élytres. Voisin de *M. quadripunctatus* Candeze, appartient au groupe *M. melanurus* Candeze—*M. bimaculatus* Fleutiaux.

Longeur, 9.5 millimètres.

Iles Philippines, Mindanao, Davao (*Baker*).

Melanoxanthus insignis sp. nov.

Allongé, convexe, atténué en arrière; pubescence fine. Tête jaune avec un tache noire arrondie en arrière, convexe et densément ponctuée. Antennes noires, minces et courtes. Pronotum convexe, plus long que large, parallèle en arrière, arrondi en avant, jaune avec quatre bandes longitudinales noires n'atteignant pas la base, ponctuation serrée, plus forte en arrière; angles postérieurs dirigés en arrière, fortement carénés. Ecusson

triangulaire, convexe. Elytres atténués graduellement dès la base, échancrés au sommet, noirs avec chacun une bande jaune subsutural s'arrêtant au de lá de la moitié, et un bande transversale au dessous ne touchant pas les bords latéraux ni la suture, finement rugueux, ponctués-striés. Dessous jaune, métasternum et dernier segment abdominal noirs, ponctuation fine. Sutures prosternales parallèles. Hanches postérieures peu rétrécies en dehors. Dernier arceau ventral arrondi au sommet. Pattes jaunes; tarses noirs.

Voisin de *M. quadrilineatus* Schwarz; les bandes noires latérales du pronotum n'atteignant pas la base, pas de tache noire sur les propleures, pas de tache jaune à l'extrémité des élytres.

Longeur, 12 millimètres.

Iles Philippines, Mindanao, Davao (*Baker*).

NEW OR NOTEWORTHY PHILIPPINE BIRDS, III

By RICHARD C. MCGREGOR

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FOUR PLATES

Canutus rogersi Mathews.

Tringa canutus SHARPE, Cat. Birds. Brit. Mus. 24 (1896) 593 (part.).
Canutus canutus rogersi MATHEWS, Birds of Australia 3[8] (1913) 270; RIDGWAY, Bull. U. S. Nat. Mus. 50[8] (1919) 238 (in synonymy).

Two sandpipers collected at Obando, Bulacan Province, Luzon, in 1910 were doubtfully identified as *Tringa canutus* as they are smaller in all measurements than the Asiatic knot. Dr. C. W. Richmond, of the United States National Museum, has kindly examined these two specimens and has labeled them *Canutus canutus rogersi.* The lower parts of No. 7378 are mottled with ochraceous buff and the upper parts retain a few scattered, worn, black feathers of the summer plumage. This specimen measured 250 millimeters in length in the flesh. The other specimen, which was collected a day earlier, is in complete, fresh, winter plumage.

Measurements of knots.

CANUTUS ROGERSI.

No.	Sex.	Locality.	Date.	Wing.	Tail.	Culmen	Tarsus.	Middle toe with claw.
				mm.	*mm.*	*mm.*	*mm.*	*mm.*
7376	♂	Obando, Bulacan, Luzon	Nov. 15, 1910	160	65	33	29	26
7378	♀	do	Nov. 16, 1910	165	61	31	29	27

CANUTUS TENUIROSTRIS.

12935	(?)	Cavite, Luzon	Nov. 13, 1909	174	67	41	35	28
7377	♀ ?	Obando, Bulacan, Luzon	Nov. 15, 1910	179	70	43	34	28
13328	♀	do	Nov. 25, 1916	175	68	42	33	28

Canutus tenuirostris (Horsfield).

Tringa crassirostris TEMMINCK and SCHLEGEL, Fauna Japonica (1847) 107; SHARPE, Cat. Birds Brit. Mus. 24 (1896) 600 (part.); McGREGOR, Man. Philip. Birds (1909) 141 (Mindanao? and Negros).
Anteliotringa tenuirostris MATHEWS, Birds of Australia 3 [8] (1913) 277 (*Totanus tenuirostris* Horsfield).
Canutus tenuirostris RIDGWAY, Bull. U. S. Nat. Mus. 50 [8] (1919) 231.

The Asiatic knot was collected in Negros by Moseley and by Bourns and Worcester, and Mearns had at least one Philippine specimen, probably from Mindanao. I am now able to record three specimens that were collected in Luzon. The one from Cavite was collected by Dr. H. C. Curl, who recorded its length as 270 millimeters. No. 7377 was 275 millimeters in length in the flesh. Other measurements of the three specimens are given in the table under the preceding species and need not be repeated here.

Mathews has attached the generic name *Anteliotringa* to this species, but I do not think it is necessary to separate it generically from the smaller knots.

Muscicapula calayensis sp. nov.

Muscicapula luzoniensis McGREGOR, Bull. Philip. Mus. 4 (1904) 32 (part referring to Calayan).

Type.—No. 3405, adult male, Bureau of Science collection; Calayan Island, Babuyanes, P. I.; October 1, 1903; R. C. McGregor and A. Celestino, collectors. Length, in the flesh, 127 millimeters; wing, 63; tail, 49; tarsus, 18; exposed culmen, 12. Bill black; iris dark; legs white with a slight blue wash; nails light brown.

Specific characters.—Similar to *Muscicapula luzoniensis* Grant, but chin, throat, breast, and sides darker—dark ochraceous-buff to dark antimony yellow instead of chamois yellow; wing and bill slightly longer.

Remarks.—I recorded this specimen as *M. luzoniensis*, but its darker underparts and slightly greater size are sufficient grounds for its separation.

Gerygone simplex Cabanis. Plates 1 and 2.

The muscicapine genus *Gerygone* includes about twenty-five species of small, somewhat aberrant flycatchers. Several species are found in Australia, while others inhabit various parts of the Sunda Islands, Papua, Borneo, Sumatra, and the Malay Peninsula. *Gerygone simplex*, which appears to be confined to the Philippine Islands, has been recorded from Mindoro, Luzon, and

two of the small islands near Luzon. Mearns has described *Gerygone rhizophoræ* from Mindanao, but there seems to be no record of the genus from Samar, Negros, and the other islands. My experience with *Gerygone simplex* indicates that it prefers mangroves and open, second-growth bamboo.

Mr. E. H. Taylor recently found this flycatcher nesting in the vicinity of Alabang, Laguna Province, Luzon. The nests were in second-growth shrubs and bushes.

One nest was about 2 meters from the ground in a spiny shrub, *Capparis horrida* Linnæus (Plate 1). It is composed of plant fibers and covered with cobwebs. It is suspended near the end of a small twig, and its general appearance suggests the nest of some sunbird or bushtit. This nest is about 30 centimeters long and 5 centimeters broad. At the middle of one side there is a circular opening about 2.5 centimeters in diameter which is nearly concealed by an overhanging roof. This roof projects about 4 centimeters from the side of the nest. The two eggs were slightly incubated and measure 15.8 by 12 and 16.6 by 12.2 millimeters, respectively. The ground color is very pale pinkish buff. Near the larger end of the egg is a definite ring formed of spots of mahogany red to Hay's russet. There are a few spots scattered over the rest of the egg.

Another nest collected on the same date, June 4, 1920, was about 3.5 meters from the ground in a large-leafed shrub, *Semecarpus cuneiformis* Blanco (Plate 2). This nest is only 20 centimeters long, and the roof over the entrance does not hide the opening so well as in the other nest. The two eggs of this set contained such large embryos that they could not be blown. These eggs are slenderer than those of the other set; the markings are more scattered and scarcely form a zone. The measurements in millimeters are 18.5 by 12.2 and 18.1 by 12.

Several species of the genus *Gerygone* are resident in Australia, and the nests and habits are described by North.[1] The picture of the nest of *Gerygone fusca* (Gould), on page 197 of North's work, resembles somewhat the longer nest of *Gerygone simplex*, but the Australian species elaborates the roof into "a narrow bottle-neck like entrance." Another nest of *Gerygone fusca*, figured by North,[2] resembles closely the long nest of *G. simplex*. The various Australian gerygones lay two or three eggs in a set.

[1] Nests and Eggs of Birds found breeding in Australia and Tasmania, Special Catal. Australian Mus. 1[1] (1904) 192–203.

[2] Op. cit. 3[1] (1911) 22.

Rhipidura nigritorquis Vigors. Plate 3.

Rhipidura nigritorquis Vigors, GRANT and WHITEHEAD, Ibis (1898) 236; OATES and REID, Cat. Birds' Eggs Brit. Mus. 3 (1903) 277, pl. 8, fig. 19.

Grant and Whitehead describe two sets of eggs of the black and white fantail that were collected by J. B. Steere in Marinduque early in May. Although this is one of the commonest Philippine species, Whitehead does not seem to have collected eggs of it himself. Oates and Reid record the two sets collected by Steere, one egg from Cebu (*Koch*), and one egg from Luzon (*Schadenberg*). The nest is described by Grant and Whitehead as being cup-shaped, composed of tightly woven fiber and wide grass bound together with cobwebs, and neatly lined with fine grasses and black fiber.

On June 4, 1920, Mr. E. H. Taylor collected a nest and three eggs of this species near Alabang, Laguna Province, Luzon. The nest was saddled on a small, nearly horizontal fork of a shrub; it is smooth, regular in shape, and compactly made of small twigs, rootlets, and other vegetable materials (Plate 3). The outside of the nest is smooth, and the materials are closely matted. The outside diameter of the nest is about 65 millimeters; outside depth, 50; inside depth, 35.

The eggs are very light brown and are marked with small spots and blotches of snuff brown, Saccardo's umber, and sepia, which form a poorly defined zone just above the greatest diameter and are scattered evenly toward the ends of the eggs. The eggs measure, in millimeters, 19.3 by 13.9, 19 by 13.9, and 19 by 14.1.

Xeocephus rufus (Gray).

In Sharpe's [3] key to the genera of the Muscicapidæ *Xeocephus* falls under "*k*" Tail graduated, the two centre feathers not exceeding the next one by as much as the length of the culmen." This is true of most specimens of *Xeocephus* that I have collected; it is also true of nonbreeding and immature examples of *Terpsiphone*. In some males of *Xeocephus rufus* the central rectrices greatly exceed the others. Therefore *Terpsiphone* and *Xeocephus* cannot be separated by Sharpe's key, and I do not know on what characters they can be distinguished. I have seen no specimen of *X. cinnamomeus* with long rectrices, but it would be strange if they were not developed in the breeding male.

For the blue *Xeocephus*, of Palawan, I propose—

[3] Cat. Bds. Brit. Mus. 4 (1879) 116.

Subgenus **NEOXEOCEPHUS** novum

Subgeneric characters.—Similar to *Xeocephus*, but crest full and long, the feathers loose and hairlike; eye wattle (if present) very narrow; tail strongly graduated, but central pair of rectrices not known to be greatly lengthened. The type and only species is *Zeocephus cyanescens* Sharpe.

Xeocephus cyanescens Sharpe.

This species is confined to Palawan and the Calamianes; the distribution, together with the entirely different coloration, would suggest the generic or subgeneric separation of the species from *Xeocephus*. Whether or not the adult male of this species has streamerlike central rectrices seems to be unknown. I have examined seven males collected in January, February, July, and December, and find the rectrices moderately graduated in all of them. There is no suggestion of the central pair being streamerlike.

The predominant color of *Xeocephus cyanescens* is blue. The immature plumage differs considerably from that of the adult. A male collected in Palawan on July 1, 1910, shows that in the young the wings and upper parts are brown, while the blue of the throat, breast, and abdomen is very pale. The back and wings are tawny to ochraceous tawny; primaries dark brown; upper tail coverts and rectrices russet; head, chin, and throat covered with short pin feathers that do not indicate any color; breast and sides deep Dutch blue, fading to white on abdomen; under tail coverts white, washed with clay color. The remiges are much worn except the eighth and ninth primaries which are fresh blue feathers of the adult plumage; a few of the primary and secondary coverts are also of the new blue plumage.

I propose a subgeneric name for this blue flycatcher to call attention to its difference from typical *Xeocephus*, but my opinion is that both *Callaeops* and *Xeocephus* should be considered as no more than subgenera of *Terpsiphone*.

Terpsiphone periopthalmica (Grant). Plate 4.

Callaeops periopthalmica Grant, Bull. Brit. Orn. Club 4 (1895) 18; Ibis VII 1 (1895) 253 (not "275"); Whitehead, Ibis VII 5 (1899) 108; Sharpe, Hand-List 3 (1901) 263; McGregor and Worcester, Hand-list Philip. Bds. (1906) 74 (not "94"); McGregor, Man. Philip. Bds. (1910) 464; Hartert, Novit. Zool. 23 (1916) 335, pl. 1; Richmond, Auk 34 (1917) 215.

Callæops periopthalmica Dubois, Synop. Av. 1[4] (1900) 288.

Terpsiphone nigra McGregor, Philip. Journ. Sci. § A 2 (1907) 340, pls. 1–3; Man. Philip. Bds. (1910) 466.

The publication of a colored plate illustrating the type of *Callaeops periopthalmica* and Richmond's comment on this species, as well as a letter from Dr. C. W. Richmond with regard to the species, have led me to reëxamine the specimens of "Terpsiphone nigra" in the Bureau of Science collection.

The type of *C. periopthalmica* was purchased by John Whitehead from Brolio Barboza, a Filipino taxidermist, with whom I was well acquainted. The collector assured me that the specimen was killed with a blow gun near Malabon, a small town a few kilometers from Manila. Like many other taxidermists this man kept no record of his specimens and so was unable to furnish me any other information about this bird. Who really killed the bird is doubtful and is of no consequence, but I think it probable that the bird was really collected near Manila. In the vicinity of Malabon the vegetation is entirely unsuited to such birds as the long-tailed flycatchers. Therefore, I think there can be no doubt that the type of "Callaeops" was a wind-driven individual far from its normal habitat. Unfortunately we do not know the date on which this specimen was collected.

In May, 1907, through the courtesy of Gen. Leonard Wood, in company with the late Col. E. A. Mearns, I was able to visit Batan Island, one of the most northern islands of the Philippine Archipelago. On that island I was delighted to find a long-tailed, black and white flycatcher of which we collected a good series. This I described as *Terpsiphone nigra,* but I noted that some of the specimens agreed with the description of *Callaeops periopthalmica.* The type of the latter species has passed to the Tring Museum, and Hartert has published some comment on the species and a colored plate of the type. Richmond has published some further notes on the species.

Hartert's colored plate shows a bluish black bird with the abdomen and the tips of the inferior tail coverts white. Twelve graduated rectrices are shown, the middle pair being the narrowest; the greatest differences in length are between the first and the second pairs and between the fifth and the sixth pairs.

That "Terpsiphone nigra" breeds before it attains the full black plumage is indicated by specimen 6440 in which one of the central rectrices is considerably lengthened and the other is nearly as short as the next pair; the latter feathers are not conspicuously longer than the third pair (Plate 4, fig. 1). This specimen is a male collected June 5, and is marked "breeding male." The abdomen is extensively whitish, and the inferior tail coverts are entirely cinnamon. The head and neck are

black, but the mantle and rump are about walnut brown. I have stated that "The short-tailed black males of this flycatcher agree with the description of *Callaeops periopthalmica*," but I find that the two short-tailed black males in the collection, on which I based this statement, are imperfect, the long, streamer-like rectrices having been shot away. However, if the long rectrices are molted in the nonbreeding season, the adults will closely resemble Hartert's plate.

La Touche,[4] writing on *Terpsiphone incii* (Gould) in China, says:

> In spring most of the males have the long central rectrices, and breed in the red plumage as well as in the white. The latter plumage, which is that of the old males at least two years old, is without doubt moulted at the end of the summer before the autumn migration begins.

With reference to the same species I take the liberty of quoting from a letter written by Mr. La Touche at Mengtsz, Yunnan, China, on November 3, 1920, as follows:

> During the period 1882–1919, when I paid much attention to China birds, I never once obtained or saw a male in white plumage on the autumn migration. Hence my remark. Now, in this place, I have this autumn obtained *three* white males, *all with short tails*. In this province at least, *T. incii* retains the white plumage after the summer but has dropped the long central rectrices just as is the case with the Indian birds.

The type of *Terpsiphone nigra*, which appears to be the most adult male collected by me, has a little white on the middle of the abdomen, but none on the tips of the inferior tail coverts (Plate 4, fig. 2). The bases of these coverts are white and the inner edges are light clay brown. This is the only specimen with the inferior tail coverts nearly all black. Each of seven other long-tailed males has more white on the abdomen than the type, and the coverts are white or clay brown; but in none are the coverts black with clear white tips as shown in the colored plate of *Callaeops periopthalmica*.

In some specimens of *Terpsiphone nigra*, the axillars and inferior wing coverts are more or less white, and in others these feathers are entirely black. In none is the white so conspicuous as in *T. princeps*. It should be noted that in the adult, breeding male the two central rectrices are not the only ones lengthened, for the next two pairs are much longer than in immature birds. It seems probable that the type of *Callaeops periopthalmica* is an adult male in nonbreeding plumage. This supposition

[4] Ibis XI 2 (1920) 666.

is sustained by the condition of a male specimen of *Terpsiphone princeps* (Temm.) collected at "Hiuga-Kiushū," Japan, on August 5, 1894. In this specimen the rectrices are graduated, with the central pair slightly narrowed; the greatest differences in length are as shown in Hartert's plate of *Callaeops*.

For the present I am satisfied to let *Terpsiphone nigra* stand as a synonym of *Callaeops periopthalmica*, but I do not feel sure that a long-tailed black flycatcher will not be discovered in Luzon. *Callaeops* is no more than a subgenus of *Terpsiphone*.

The distribution of the species is: Batan Island, Batanes, resident; accidental near Manila, Luzon, P. I.

ILLUSTRATIONS

PLATE 1

A nest of *Gerygone simplex* Cabanis, from Alabang, Luzon, P. I.

PLATE 2

A nest of *Gerygone simplex* Cabanis, from Alabang, Luzon, P. I.

PLATE 3

A nest of *Rhipidura nigritorquis* Vigors, from Alabang, Luzon, P. I.

PLATE 4

FIG. 1. *Terpsiphone periopthalmica* (Grant). A breeding male in immature plumage, with one of the middle rectrices lengthened. No. 6440.

2. *Terpsiphone periopthalmica* (Grant). An adult breeding male, with well-developed rectrices. No. 6395, type of *Terpsiphone nigra* McGregor.

3. *Terpsiphone periopthalmica* (Grant). A female in adult plumage. No. 6495.

PLATE 1. A NEST OF GERYGONE SIMPLEX CABANIS.

PLATE 2. A NEST OF GERYGONE SIMPLEX CABANIS.

PLATE 3. A NEST OF RHIPIDURA NIGRITORQUIS VIGORS.

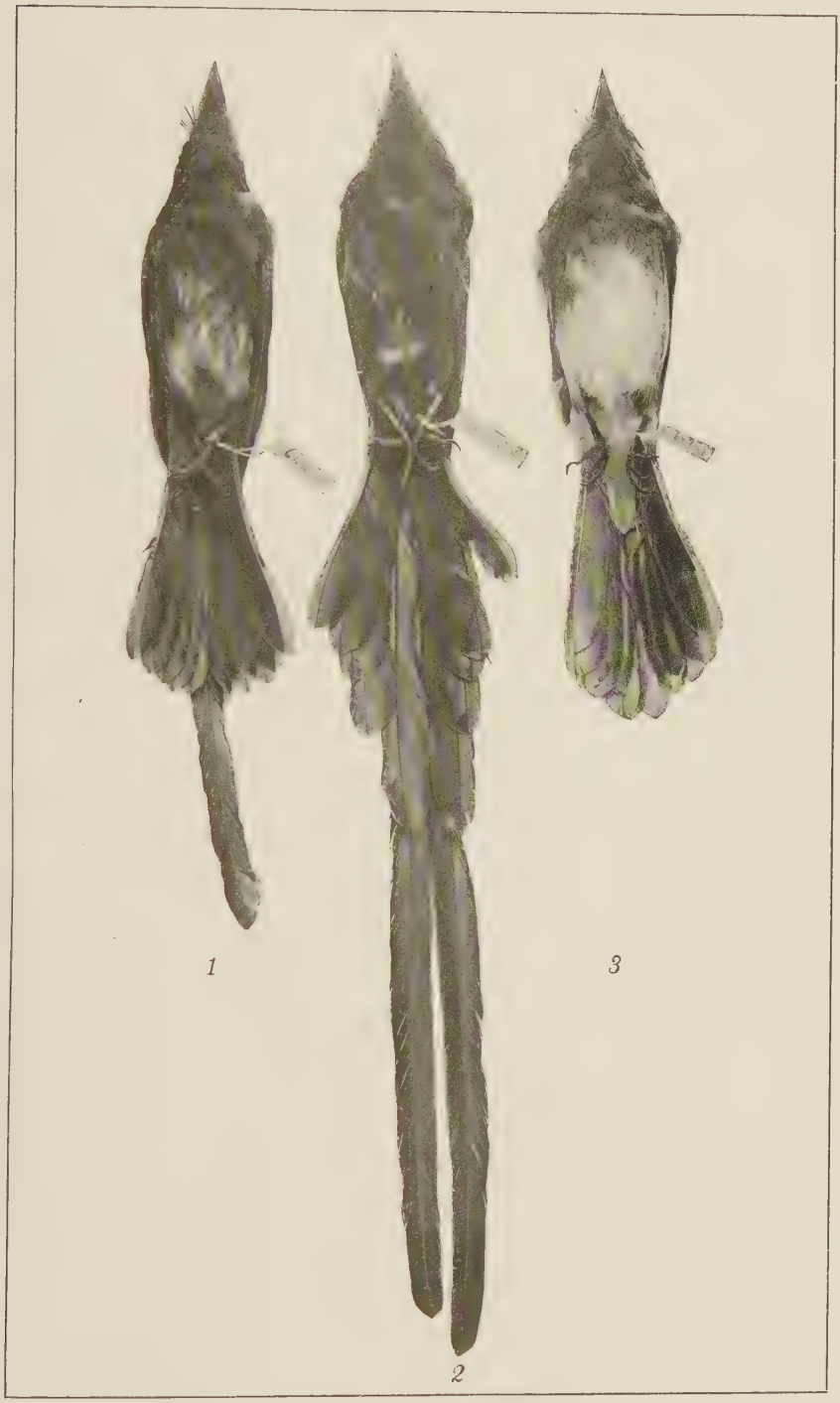

PLATE 4. TERPSIPHONE PERIOPTHALMICA (GRANT).

THE RELATION OF STOCKS TO MOTTLED LEAF OF CITRUS TREES [1]

By H. Atherton Lee

Pathologist, Office of Fruit Disease Investigations, United States Department of Agriculture

THREE PLATES

INTRODUCTION

Mottled leaf of citrus trees has become increasingly important within the last few years in the citrus-growing regions of the United States and has been the subject of much discussion among growers, physiologists, and pathologists. The present paper submits definite data concerning the relation of stocks to mottled leaf which may contribute slightly to our knowledge of the disease. The data also make possible a suggestion for its future control.

BRIEF HISTORY OF THE DISEASE

A number of hypotheses have been advanced to explain the cause of this disease, based usually on substantial investigations in some one area where trees were badly affected. Thus Hilgard,[2] in 1906, advanced the theory of an excess of lime as a cause of mottled leaf in the Porterville region in California. His conclusions were based upon his observations of the occurrence of the disease in areas where lime was considerably in excess. Another theory, somewhat in opposition to that of an excess of lime, was advanced by Snowden,[3] and depended on an improper relationship of calcium to magnesium in the soil, it being ex-

[1] The writer is greatly indebted and herein expresses gratitude to Mr. S. Apostol, chief of the Division of Plant Industry of the Philippine Bureau of Agriculture, for the use of the citrus orchards at Lamao. The use of the orchards, as well as living accommodations at Lamao, were made available through the efforts of Mr. Apostol; without this unusual opportunity the work would have been impossible.

[2] Hilgard, E. W., Marly subsoils and chlorosis or yellowing of citrus trees, Univ. Calif. Agr. Exp. Sta. Circular 27 (1906).

[3] Snowden, R. R., The magnesia lime trouble in citrus orchards, California Cultivator (1910) 124.

plained that the proportion of magnesium to calcium was too great in areas where mottled leaf was found. This explanation was apparently not so well supported by evidence as was Hilgard's.

It was shown by Thomas [4] that, in a large number of cases, nematodes were to be found upon the roots of trees with mottled leaf. These observations by Thomas were taken in representative districts of California. The conclusion that nematodes were a direct cause of mottled leaf was abandoned, however, by the subsequent finding of mottled leaf trees, upon the roots of which no nematodes could be found.

Smith and Smith [5] found mottled leaf to be associated with poorly drained soils, and with soils of a poor physical texture. Mottled leaf was also recorded by them as accompanying excesses of manure or as occurring on trees situated near stables or corrals where there was an excess of organic matter. They concluded that mottled leaf was a result of an irregular supply of food and moisture. Kellerman and Wright,[6] in 1914, claimed to have correlated the occurrence of mottled leaf with soils in which there was an excess of nitrate nitrogen. They stated that the turning under of straw and other substances high in cellulose increased the amount of mottled leaf; the explanation apparently advanced was that the cellulose-dissolving bacteria, which increased when straw was turned under, used up at the same time large amounts of nitrate nitrogen. They claimed to have induced mottling, artificially, by introducing into the soil straw and other substances high in cellulose, and suggested the turning under of green cover crops as a means of preventing mottled leaf. Lipman,[7] in 1915, advanced an interesting theory in explanation of the cause of mottled leaf; his conclusion was that the disease was caused by a lack of nitrogen in an available form, and was based upon field observations and pot experiments. He suggested that, although the total nitrogen content of the soil might be high, such nitrogen was not necessarily in an available form,

[4] Thomas, E. C., A preliminary report of a nematode observed on citrus roots and its possible relation with the mottled appearance of citrus, Calif. Agr. Exp. Sta. Circular 85 (1913).

[5] Smith, R. E., and Smith, E. H., California plant diseases, Calif. Agr. Exp. Sta. Bull. 213 (1911) 1137–1159.

[6] Kellerman, K. F., and Wright, R. C., Relation of bacterial transformations of soil nitrogen to nutrition of citrous plants, Journ. Agr. Res. 2 (1914) 101.

[7] Lipman, Chas. B., A suggestion of a new phase of the problem of physiological diseases of plants, Phytopathology 5 (1915) 111.

and that the soil flora of that locality possibly was not able to convert the nitrogen into an available form.

Briggs, Jensen, and McLane,[8] in 1916, found that mottled leaf in citrus was correlated in a large number of cases with a low humus content.

McBeth[9] showed, in 1917, that mottled leaves generally have a higher nitrogen content and a higher moisture content than normal leaves. He concluded from his work that an irregular food and moisture supply was a cause of mottled leaf, and corroborated the view advanced by Smith and Smith. Briggs, Jensen, and McLane,[10] in 1917, showed control of mottled leaf in a number of cases by the use of mulches, combined with basin irrigation, which carried organic material into the soil and also maintained the temperature of the soil more uniformly. They concluded that lack of humus is a cause of mottled leaf. The use of the mulched basin system of irrigation has not been accepted generally by growers, however, because this practice possesses several disadvantages.

Jensen,[11] in 1917, showed that very badly mottled leaves of orange and lemon contained higher percentages of iron, calcium, magnesium, and phosphoric acid than did healthy leaves. He also observed, in general, an increase in the percentage of these elements in the leaf stems and midribs, indicating difficulty in their transfer to the mesophyll tissues in the later stages of mottling. This apparently is not advanced as a cause but as a contribution to the general understanding of the disease.

Floyd,[12] in 1917, found mottled leaf in Florida to be correlated with the use of excessive amounts of ground limestone. He was able to induce the mottled leaf symptoms by adding ground limestone to the soil of potted plants. The writer has seen the mottled leaf in Florida which Floyd describes; apparently the yellowing between the veins, the stunting of the leaves, and the

[8] Briggs, L. J., Jensen, C. A., and McLane, J. W., Mottle-leaf of citrus trees in relation to soil conditions, Journ. Agr. Res. 6 (1916) 721–759.

[9] McBeth, I. G., Relation of the transformation and distribution of soil nitrogen to the nutrition of citrus plants, in Journ. Agr. Res. 9 (1917) 183.

[10] Briggs, L. J., Jensen, C. A., and McLane, J. W., The mulched basin system of irrigated citrus culture and its bearing on the control of mottle-leaf, U. S. Dept. Agr. Bull. 499, professional paper (1917).

[11] Jensen, C. A., Citrus leaves at various stages of mottling. In Journ. Agr. Res. 9 (1917).

[12] Floyd, B. F., Some cases of injury to citrus trees apparently induced by ground limestone, Florida Agr. Exp. Sta. Bull. 137 (1917).

thickness and the greater toughness of the leaves differ in no way from the symptoms known in California as mottled leaf.

According to this brief review, a number of causes have been ascribed to mottled leaf, all of them being advanced after a careful study of the disease which sometimes extended over a considerable period of time. It would seem reasonable to conclude from this review of past studies that the complex of symptoms known as mottled leaf may be induced by several different types of injury, any one of which may cause the same reaction of the plant. That is, several types of injury to citrus trees may produce the same ultimate reaction and symptoms.

OBSERVATIONS ON MOTTLED LEAF AT LAMAO, PHILIPPINE ISLANDS

The Philippine Bureau of Agriculture maintains a horticultural station and plant propagation garden at Lamao, in Bataan Province near Manila. At this experiment station there are three orchards which contain a number of American and Japanese citrus varieties, and very extensive nurseries for the propagation of these varieties. These extensive collections and introductions are the work of Mr. P. J. Wester, of the Philippine Bureau of Agriculture. The writer is greatly indebted to Mr. Wester for assistance in identifying varieties at Lamao, and for numerous kindnesses in many other ways, and herein he expresses his deep appreciation to him.

The orchard trees and nursery trees at Lamao are planted upon stocks of different species; the stocks represented are the pummelo (*Citrus maxima*), the cabuyao (*Citrus hystrix*), the sour orange (*Citrus aurantium*), the sweet orange (*Citrus sinensis*), the calamondin (*Citrus mitis*), and the mandarin orange (*Citrus nobilis*).

It was noticed that a considerable amount of mottled leaf was present in the nurseries, and that there was also mottled leaf in the mature orchards, although to a less extent. The type of mottling was entirely the same as that seen in California, the leaves yellowing slightly between the veins in the less-affected cases, while in the more severe cases the leaves became yellow to include all of the leaf-blade tissue with the exception of the main veins and midrib, which remained green. The affected leaves were stunted in size, thickened, and more leathery than were the normal leaves. It gradually became evident that there was a correlation between the occurrence of mottled leaf and the species used for a stock. A determination was made for each

tree of the occurrence of mottled leaf, the variety and species on which the disease showed, and the species of the stock. A summary of these observations is presented in the following tables:

TABLE 1.—*Number of trees affected with mottled leaf upon pummelo stocks.*[a]

Pummelo stocks budded with—	Total trees.	Trees affected with mottled leaf.	
		Number.	*Per cent.*
Calamondin	3	0	0.00
Lime	28	2	7.14
Pummelo	175	27	15.42
Pummelo stocks unbudded	86	14	16.27
Lemon	99	53	53.53
Mandarin orange	348	259	74.42
Cabuyao	4	3	75.00
Grapefruit	127	98	77.16
Sweet orange	223	191	85.65
Tangelo	50	48	96.00

[a] The term pummelo is used here to indicate the East Indian form of *Citrus maxima;* in the West Indies the term shaddock is used for the same type of fruits. The tangelo is a hybrid between the tangerine and the grapefruit.

TABLE 2.—*Number of trees affected with mottled leaf upon cabuyao stocks.*

Cabuyao stock budded with—	Total trees.	Trees affected with mottled leaf.	
		Number.	*Per cent.*
Calamondin	2	0	0.00
Cabuyao	2	0	0.00
Sour orange	2	0	0.00
Lemon	1	0	0.00
Pummelo	1	0	0.00
Sweet orange	19	5	26.31
Tangelo	11	7	63.65
Mandarin orange	3	2	66.66

TABLE 3.—*Number of trees affected with mottled leaf on sour orange stocks.*

Sour orange stock budded with—	Total trees.	Trees affected with mottled leaf.	
		Number.	*Per cent.*
Pummelo	18	1	5.55
Grapefruit	8	1	12.5
Lemon	7	1	14.28
Mandarin orange	34	8	23.52
Sweet orange	28	12	42.85

TABLE 4.—*Number of trees affected with mottled leaf on calamondin stocks.*

Calamondin stock budded with—	Total trees.	Trees affected with mottled leaf.	
		Number.	*Per cent.*
Calamondin	6	0	0.00
Cabuyao	2	0	0.00
Sour orange	3	0	0.00
Lime	2	0	0.00
Grapefruit	22	2	9.09
Mandarin orange	113	11	9.73
Lemon	24	3	12.50
Sweet orange	93	12	12.90
Pummelo	11	2	18.18
Tangelo	22	4	18.18

TABLE 5.—*Number of citrus trees affected with mottled leaf on mandarin orange stocks.*

Mandarin orange stock budded with—	Total trees.	Trees affected with mottled leaf.	
		Number.	*Per cent.*
Cabuyao	14	0	0.00
Sour orange	10	0	0.00
Stock unbudded	84	0	0.00
Lime	8	0	0.00
Pummelo	68	0	0.00
Grapefruit	10	0	0.00
Mandarin orange	138	2	1.44
Sweet orange	70	3	4.28
Lemon	63	17	26.98

Previous work on this subject has offered little opportunity for a comparison between the various citrus species as to their susceptibility to mottled leaf; the above tables will indicate such comparative susceptibility in a general way. Although it will be impossible to arrange the species in the order of susceptibility (from these tables at least), still it can be said that the calamondin and the lime exhibit the mottled leaf symptoms but slightly; and that the tangelo, sweet orange, and mandarin orange varieties are most commonly affected by mottled leaf.

The relationship of the stocks to mottled leaf is indicated in the foregoing tables by comparison of the figures in the various tables for a given species; as, for instance, the sweet orange, which is recorded in all of the tables. Thus, the sweet orange on pummelo stock developed 191 cases of mottled leaf of a total of 223 trees so propagated, or 85.65 per cent of positive cases. Sweet orange propagated upon cabuyao stock developed 5 cases of mottled leaf from a total of 19 trees budded on cabuyao, or 26.31 per cent. Sweet orange on sour orange stock developed

12 cases out of 28 trees, or 42.85 per cent. Sweet orange on calamondin stock developed 12 cases out of 93 trees, or 12.90 per cent, and of 70 trees propagated on mandarin orange stock only 3, or 4.28 per cent, developed mottled leaf.

Similar comparison with reference to other species shows high percentages of mottled leaf on pummelo stocks, lower ones on cabuyao and sour orange stocks, and but small percentages on calamondin and mandarin orange stocks. A table has been prepared, combining all the species upon a given stock, and is given here as it presents a more comprehensive summary of the relationship of stocks to mottled leaf.

TABLE 6.—*Summary of the influence of various citrus species as stocks upon the susceptibility of citrus trees to mottled leaf.*

Stock.	Total trees.	Trees affected with mottled leaf.	
		Number.	*Per cent.*
Pummelo	1145	695	60.80
Cabuyao	41	14	34.14
Sour orange	95	23	24.21
Calamondin	298	34	11.4
Mandarin orange	465	22	4.73

The differences between the stocks were even more impressive in the nursery rows than they seem when summarized in tables. Moreover, the effect of mottled leaf on the growth of the trees was very striking. Trees of the Valencia orange or Oneco mandarin, for instance, made a very substantial growth on mandarin orange stock. The same varieties, of the same age, on pummelo stocks of the same age in adjoining rows, were much smaller at the time of the observation and lacked the vigorous appearance of the trees on the other stocks. The photographs, Plates 2 and 3, show the comparative growth of trees upon pummelo and mandarin stocks.

The effects of the pummelo stock in inducing mottled leaf were very noticeable. A row of trees budded upon this stock would be badly mottled and stunted; a tree would then occur on which the scion had not grown and the stock had developed in its place. Such a tree of the unbudded stock would be perfectly normal, with no trace of mottled leaf, and much greater in size than the budded trees upon the pummelo stock. Very commonly, also, a pummelo scion upon pummelo stock would develop entirely free of the disease and make a normal growth. This and the observation that the mandarin and other species mottled badly on pummelo, while the pummelo itself on pummelo seldom if

ever exhibited the symptoms, led to the conclusion at first that this species was in some way incompatible to the sweet orange and mandarin orange species. That is, it was thought that possibly the mandarin orange and sweet orange species were not closely enough related to the pummelo to bud well. However, this theory was abandoned since the converse, pummelo budded on mandarin orange in near-by rows under identical conditions, did not result in mottled leaf but made perfectly normal growth.

The correlation of the pummelo stocks to mottled leaf presented in this paper is not advanced as a cause of the disease but as a factor conducive to mottled leaf if the conditions are favorable. That is to say, it is believed that trees upon pummelo stocks mottle only when the other contributing factors are present, while if such factors are absent the trees will remain perfectly normal. The use of pummelo stock therefore is conducive to mottled leaf only when the original contributing cause or causes are present. Trees upon mandarin orange stock, however, have but little mottled leaf, even in the presence of one of the series of contributing causes.

A plausible assumption for the different reactions of the different species on various stocks would seem to be the comparative resistance and susceptibility of such stocks. Thus it would seem that the mandarin orange and the calamondin as stocks are resistant to the peculiar environmental conditions at Lamao which are conducive to mottled leaf; the pummelo as a stock would seem to be extremely sensitive. No analysis as to the reasons for such resistance and susceptibility is possible from the data at present available. However, the practical application is immediately apparent; that is, it would seem possible in such regions where the soils have been shown to be favorable to mottled leaf to minimize injury from this disease by the use of the proper stocks.

THE SOIL AT LAMAO

Soil conditions have been so closely connected with mottled leaf in previous literature that such a brief description as is possible is presented here for the use of others interested in this disease. The soil at Lamao is fairly uniform in physical texture throughout all the citrus orchards. It is probably of alluvial origin and may be classed as a sandy loam; this sandy loam extends to a depth of from 2.5 to 3 meters before gravel is reached. The drainage throughout the orchards is very good and water never stands upon the surface of the soil. During the dry season it is possible that irrigation is sometimes irregular.

To the unaided eye there is no evidence of any considerable amount of decaying organic matter in the soil. The nurseries and orchards are given very much the same treatment that orchards in the United States would receive. In the dry season they are clean cultivated and a good dust mulch is maintained. In the wet season a small crop of weeds grows up which is plowed under at the close of the rains.

THE USE OF STOCKS IN CONNECTION WITH MOTTLED LEAF

From a commercial viewpoint the data presented here would indicate that the use of pummelo varieties of *Citrus maxima* under certain conditions is to be avoided. In the Philippines under the same conditions, where mottled leaf occurred severely upon pummelo stock, trees upon mandarin orange and calamondin stocks were affected but slightly, or not at all. It is suggested, therefore, that in areas where mottled leaf prevails the promising types of mandarin orange and calamondin, if given a trial as stocks, might give good results. The mandarin orange is used as a stock almost exclusively in the Swatow region in China, and is found to give very satisfactory results. It should be understood definitely that the mandarin orange or calamondin stocks are not recommended here for orchard practice until they have been thoroughly tried out experimentally under the local conditions in which it is intended to utilize them. They are suggested here only as promising for such a trial.

SUMMARY

1. The history of the disease has shown that a number of careful investigations at different times and in different places have pointed to different factors as causing mottled leaf. It would seem possible that the symptoms of mottled leaf accompany several different types of malnutrition, and are not necessarily the result of excess or lack of any one substance in the soil.

2. In the Philippines it was observed that trees upon pummelo stock were badly affected with mottled leaf. Trees upon mandarin orange and calamondin stocks under the same conditions did not mottle. The relationship of stocks to mottled leaf in this case is not advanced as a cause of the disease, but it would seem that certain stocks are conducive to mottled leaf when the causal factors are present. The calamondin and mandarin orange when used as stocks apparently enable the tree to avoid the disease, even though the causal factors are present.

3. In localities where mottled leaf prevails, trees upon a mandarin orange or calamondin stock would possibly offer a solution in preventing the disease.

ILLUSTRATIONS

PLATE 1

Leaves of sweet orange variety (*Citrus sinensis*) typically affected by mottled leaf.

PLATE 2

Left, tree of mandarin orange variety on mandarin orange stock; right, two trees of same mandarin orange variety on pummelo stock showing the stunting of growth due to mottled leaf. All three trees are of the same age and were taken from adjacent rows.

PLATE 3

FIG. 1. Trees of Valencia orange. The middle tree is budded on mandarin orange stock; the two other trees are budded on pummelo stock and show the stunting effects of mottled leaf. All three trees are of the same age and were taken from adjacent nursery rows.

2. Trees of a mandarin orange variety. The middle tree is budded on mandarin orange stock; the two other trees are budded on pummelo stock and show the stunting effects of mottled leaf. All three trees are of the same age and were taken from adjacent nursery rows.

PLATE 1. LEAVES OF SWEET ORANGE VARIETY (CITRUS SINENSIS) TYPICALLY AFFECTED BY MOTTLED LEAF.

Left, tree of mandarin orange variety on mandarin orange stock; right, two trees of same mandarin orange variety on pummelo stock showing the stunting of growth due to mottled leaf. All three trees are of the same age and were taken from adjacent rows.

PLATE 2.

Fig. 1. Trees of Valencia orange.

Fig. 2. Trees of a mandarin orange variety.

PLATE 3.

AN ENUMERATION OF THE JAPANESE APHELININÆ, WITH DESCRIPTIONS OF TWO NEW SPECIES

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Of the Imperial Plant Quarantine Station of the Department of Agriculture and Commerce of Japan

ONE PLATE

The present paper enumerates the twelve known species of Japanese Aphelininæ, described by Howard, Ashmead, Fitch, Girault, and Silvestri, and two new species, which are described herein, making fourteen species recorded from Japan in this subfamily of the Chalcididæ. These minute, coccid parasites represent eight genera.

I am greatly indebted to Dr. L. O. Howard, chief of the Bureau of Entomology, of the United States Department of Agriculture, for help in the preparation of this paper.

Subfamily APHELININÆ Howard

Tribe APHELININI Ashmead

Genus ABLERUS Howard

Ablerus perspeciosus Girault.

Ann. Ent. Soc. Am. 9 (1916) 292.

Host.—*Aulacaspis pentagona* Targ.

Habitat.—Tokio, Japan.

Genus APHELINUS Dalman

Aphelinus fuscipennis Howard.

HOWARD, Revision of the Aphelininæ of North America, Tech. Ser. Div. Ent., U. S. Dept. Agr. 1 (1895) 27; KUWANA, The Coccidæ of Japan 1 (1911) 21.

Host.—*Aspidiotus perniciosus* Comst.; *Chionaspis* sp.

Habitat.—Tokio, Niigata-ken, Japan.

Aphelinus japonicus Ashmead.

Journ. N. Y. Ent. Soc. 12 (1904) 161, 162.

Habitat.—Atami, Japan.

Aphelinus mytilaspidis Le Baron.

Revision of the Aphelininæ of North America, Tech. Ser. Div. Ent., U. S. Dept. Agr. 1 (1895) 25, 26.

Host.—*Hemichionaspis aspidistræ* Sign.
Habitat.—Tokio, Shizuoka-ken, Japan.

Genus AZOTUS Howard

Azotus capensis Howard.

New genera and species of Aphelininæ, with a revised table of genera, Tech. Ser. Bur. Ent., U. S. Dept. Agr. 12[4] (1907) 75, 76, fig. 15; The Coccidæ of Japan 1 (1911) 20.

Host.—*Aulacaspis pentagona* Targ.
Habitat.—Tokio, Japan.

Azotus chionaspidis Howard.

Proc. Ent. Soc. Wash. 16 (1914) 85.

Hosts.—*Chionaspis difficilis* Ckll.; *Aulacaspis pentagona* Targ.
Habitat.—Tokio, Niigata-ken, Kanagawa-ken, Japan.

Genus COCCOPHAGUS Westwood

Coccophagus lecanii Fitch.

Revision of the Aphelininæ of North America, Tech. Ser. Div. Ent., U. S. Dept. Agr. 1 (1895) 33, 34.

Hosts.—*Ceroplastes rubens* Mask.; *Phenacoccus pergandei* Ckll.; *Pulvinaria citricola* Kuw.

Coccophagus yoshidæ sp. nov. Plate 1, fig. 1.

Female.—Length, 1.72 millimeters; wing expanse, 2.85; greatest width of forewing, 0.54. Antennæ as long as the thorax; segment 1 of funicle longer than segment 2 or 3; club segments subequal in length and each as long as segment 3 of funicle; thorax as long as the abdomen, but slightly widened toward the posterior margin; general color black; anterior and intermediate tibiæ light-colored, posterior dark-colored; eyes clear but hairy; body rather hairy; wings dusky with short cilia; marginal fringe very short, even wanting along basal three-fourths of caudal margin of forewing; tibial spur of middle leg nearly as long as basal tarsal segment.

This species was reared by Mr. Kashichi Yoshida, of the Shizuoka-ken Agricultural Experiment Station, in the vicinity of Shizuoka, from *Coccus hesperidum* Linn., in May, 1918. The specific name is given in honor of the collector of this species.

The male is unknown.
Host.—*Coccus hesperidum* Linn.
Habitat.—Shizuoka-ken, Japan.

Genus PERISSOPTERUS Howard

Perissopterus mexicanus Howard.

Revision of the Aphelininæ of North America, Tech. Ser. Div. Ent., U. S. Dept. Agr. 1 (1895) 22, 23, fig. 5b; The Coccidæ of Japan, 1 (1911) 20.

Host.—*Aulacaspis pentagona* Targ.
Habitat.—Tokio, Japan.

Genus PROSPALTELLA Howard

Prospaltella aurantii Howard.

Revision of the Aphelininæ of North America, Tech. Ser. Div. Ent., U. S. Dept. Agr. 1 (1895) 41, 42, fig. 13; The Coccidæ of Japan 1 (1911) 21.

Host.—*Aspidiotus perniciosus* Comst.
Habitat.—Tokio, Shizuoka-ken, Japan.

Prospaltella berlesei Howard.

On the parasites of Diaspis pentagona, Ent. News 17 (1906) 292, fig. [published October, 1906]; Redia 3 (1905) [published November 30, 1906] 391, fig.

Host.—*Aulacaspis pentagona* Targ.
Habitat.—Tokio, Japan.

Prospaltella niigatæ sp. nov. Plate 1, fig. 2.

Female.—Length, 0.69 millimeters; expanse, 1.53; greatest width of forewing, 0.19. Thorax broader than abdomen; length about same; pedicel as long as segment 3 of funicle which is longer and broader than segment 1 or 2; segment 2 of funicle longer than segment 1; club segments 1 and 2 subequal in length; terminal segment pointed at apex; thorax, width greater than length; general color brownish yellow; antennæ and legs light yellow; ocelli red; eyes black; abdomen black, broad anteriorly with narrow, dark bands between the segments; mesoscutellar parapsides also black; wings hyaline; veins pale yellow; forewings not so densely covered with cilia as in *Prospaltella berlesei;* marginal fringe long.

I reared this species from *Aulacaspis pentagona* Targ., infesting specimens of the mulberry tree that were brought from Tookamachi, Niigata-ken, in September, 1918, in the hope that

some parasites might be reared. Toward the end of September and in the early part of October, 1918, minute, active chalcids were bred from the scale, which differ from *Prospaltella berlesei* Howard. Specimens of the latter species were received from Prof. Antonio Berlese some time ago. This new parasite, which I name *Prospaltella niigatæ*, has long, expanded forewings, and remarkably broad thorax. Segment 2 of funicle of this new species is longer than segment 1; in *Prospaltella berlesei* segment 1 is the longer.

The male is unknown.

Host.—*Aulacaspis pentagona* Targ.

Habitat.—Tookamachi, Niigata-ken, Japan.

Tribe PTEROPTRICINI Ashmead

Genus **ARCHENOMUS** Howard

Archenomus orientalis Silvestri.[1]

Host.—*Aulacaspis pentagona* Targ.

Habitat.—Tokio, Japan.

Genus **CASCA** Howard

Casca chinensis Howard.

New genera and species of Aphelininæ, with a revised table of genera, Tech. Ser. Bur. Ent., U. S. Dept. Agr. 12[4] (1907) 83, fig. 20.

Host.—*Chionaspis difficilis* Ckll.

Habitat.—Tokio, Japan.

[1] Professor Silvestri reports that he has described this species, but I am unable to locate his literature.

ILLUSTRATIONS

[Drawings by the author.]

PLATE 1

FIG. 1. *Coccophagus yoshidæ* sp. nov., female; greatly enlarged.
2. *Prospaltella niigatæ* sp. nov., female; greatly enlarged.

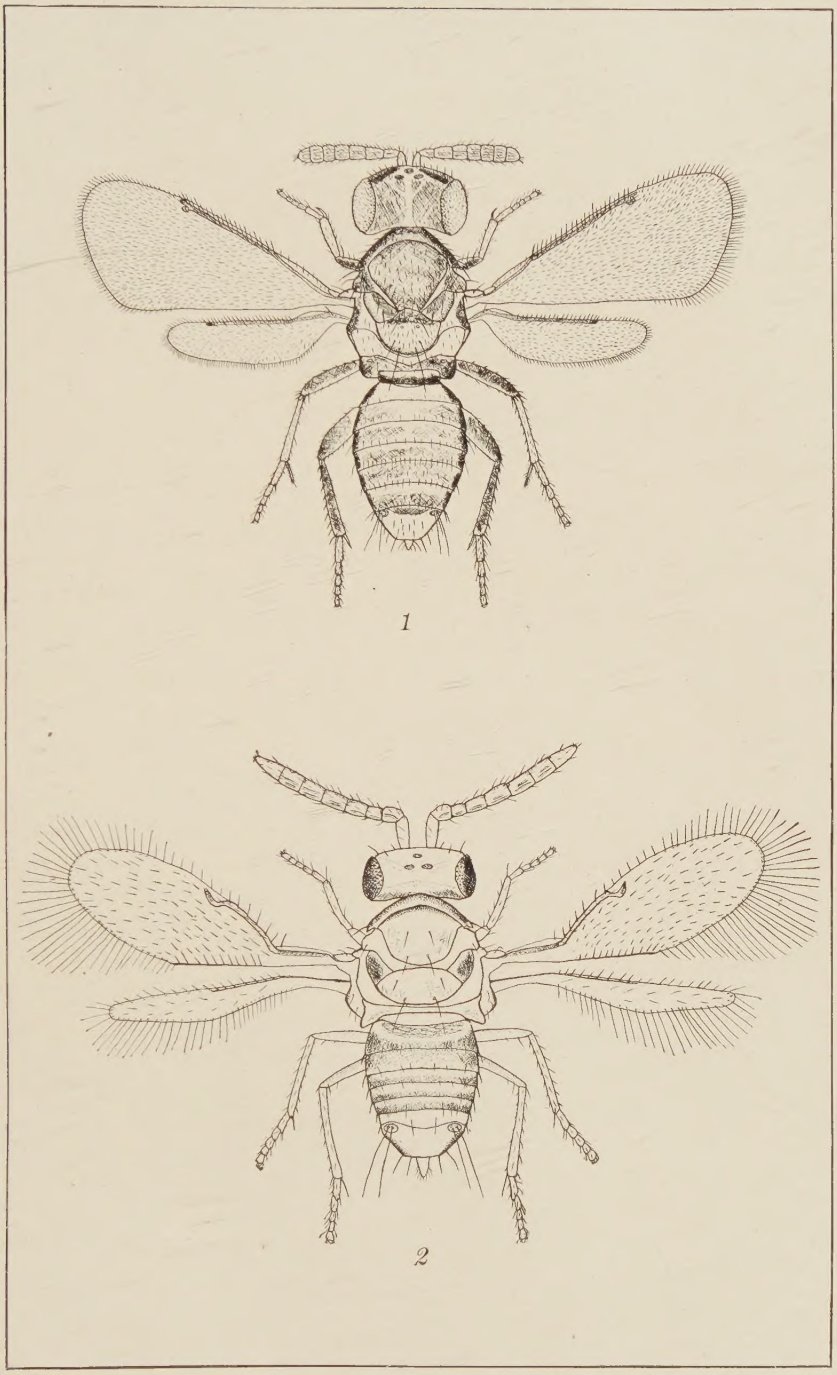

Fig. 1. Coccophagus yoshidæ sp. nov. 2. Prospaltella niigatæ sp. nov.

PLATE 1.

REVIEWS

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La Réaction | de Bordet-Wassermann | pour le | sérodiagnostic de la syphilis | étude théorique et pratique—methodes recommandées | interprétation des résultats | par | A.-D. Ronchese [two lines of titles] | Préface par M. le Professeur Fernand Widal | Masson & Cie, éditeurs | Libraires de L'Académie de Médecine | 120, Boulevard Saint-Germain, Paris | Paper, pp. i–xvi + 1–211. Price, 10 f. net.

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